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Descriptions of new processes in which electrical energy is put to what may be called illegitimate uses continue to be given out. Thus, one of the latest to be announced is that for preparing a smokeless fuel from ordinary peat. This process has been put forward in England. It consists in drying the peat by a centrifugal method, as thoroughly as possible, and then passing an electric current through to complete the work. Particular virtue is attached to this last stage, as heat is developed throughout the mass. The product is described as a clean, smokeless fuel, and it is claimed that it is equal to the best South Wales coal, and is much less expensive. Now, heat is heat, however developed, and the necessary heat required for finishing the drying process could certainly be obtained in a much less expensive manner, by the simple process of combustion. Fortunately, the commercial failure of this process is not likely to reflect in any way upon the suitability of other electrical processes.

THE GROWTH OF ELECTRIC CENTRAL STATIONS.

Bulletin No. 5 of the Bureau of the Census, issued November 30, gives the statistics of central electric light and power stations in the United States from 1881, the year which may be considered as the beginning of this industry, to the end of June, 1902. These statistics cover private and municipal plants, but they do not take into consideration electric railway stations and isolated plants, though a few of the stations classified here supply power to railways. At the time of enumeration—that is to say, seventeen months ago—there were 3,620 electric stations in operation. The cost of their construction and equipment amounted to $504,740,352. These stations furnished employment to 23,330 wage-earners, who received $14,983,112 during the year. The power plant equipment consisted of 5,930 steam engines, with 1,379,941 indicated horse-power, and 1,390 water-wheels, with a rated horse-power of 438,472. The generating plant consisted of 12,484 dynamos of every description, with a rated horse-power of 1,624,980.

Municipal Stations.

Of these 3,620 central stations, 815 are operated under the control of municipalities. These cost $22,020,473, and gave employment to 2,467 wage-earners, who were paid $1,422,341 in wages. While the number of municipal stations seems surprisingly large, being 22.5 per cent of the total, these stations represent only 4.35 per cent of the total cost. Evidently, it is the small towns that run to municipal plants.

Work of the Stations.

From the private stations 334,903 arc lamps were operated and power supplied for 16,616,593 incandescent lamps, stationary motors representing an aggregate of 19,283 horse-power and 2,370 street cars. Municipal plants operated 50,795 arc lamps, 1,577,451 incandescent lamps, 5,403 horse-power in motors, and nine railway cars. The gross income from private plants was, for the year ended June, 1902, $78,735,500, and for the municipal stations, $6,965,105, this figure including the estimated income from public service.

A Marvelous Growth.

These figures give some idea of the magnitude of this one branch of electrical application and the totals are truly marvelous when it is remembered that at the time the report was made the industry was only twenty years old. The report is now seventeen months old, and at the rate of increase indicated by the yearly figures, the number of stations should now be nearer to 4,100 than to 4,000. Also, the more recent stations are, as a rule, far more elaborate and expensive than the older ones, as there has been a growth in size of stations as noteworthy as the increase in their number, and it is very probable that the total value of the electric stations is increasing at a greater rate than they are growing numerically.

ELECTRICAL CONDUCTIVITY OF MERCURY VAPOR.

In the various published descriptions of the mercury vapor lamp and the several other devices invented by Mr. Peter Cooper Hewitt, which depend for their action upon the phenomena observed in the lamp, reference has been made to the complicated nature of these phenomena. Mr. Hewitt, in his work, has collected a large amount of data bearing on the subject, but it seemed advisable to make a systematic investigation with a view to deducing general laws.

Three Groups of Phenomena.

The reactions taking place in the tube may be divided into three groups—those taking place at the positive electrode; those taking place at the negative electrode, and the behavior of the vapor itself. In a study of any one of these groups, it is necessary to eliminate the effect of the other two, and this is not easy. Mr. Hewitt has, however, with the assistance of Dr. A. P. Wills, made a very complete investigation into the behavior of the mercury vapor, and the results of this work are to be found in a paper appearing on another page of this issue.

The Method of Conducting the Test.

The conduction of electricity through a vapor is supposed to be brought about by streams of positively and negatively charged particles, each leaving its respective electrode and traveling toward the other. These streams of charged particles, under proper conditions, form a luminous column, which varies in character with the current passing, the vapor pressure and the size of the enclosing vessel. It is necessary, therefore, to investigate the effect of variations of these three quantities, as well as to separate the three sets of phenomena. In the work described by Mr. Hewitt, the behavior of the vapor alone is described, all the electrode effects being eliminated. To obtain the latter condition was by no means easy, but Mr. Hewitt is satisfied that he has succeeded. The investigation was carried out by enclosing the tube to be experimented with in a box, arranged so as to vary the temperature. The fall of potential along the column of vapor was measured by introducing two electrodes, at a known distance apart, into the sides of the lamp. Lamps of various diameters were used, the density of the mercury vapor was varied by varying the temperature of the lamps, this temperature being determined by thermo-couples, and the current passed through the lamps was varied. It was also necessary to get rid of any impurities which might be contained in the tube. This latter condition was secured by using pure materials and carefully exhausting the tube. Under the conditions of the tests, the conducting column was perfectly uniform throughout its length, and there was a uniform fall of potential along it.

Results of the Work.

The results of the work are embodied in the curves given by Mr. Hewitt. They have not yet been formulated into mathematical equations, but this is now being done. In general, the behavior of the mercury vapor may be stated in this way: the resistance per unit length of the vapor column decreases with an increase in the diameter of the tube, with an increase in the current flowing, and with a decrease in the vapor pressure. The watts absorbed per centimetre of length vary, of course, with the current and the resistance. Other things being equal, they increase with an increase in current, with an increase in the diameter of the tube, and with an increase in the vapor pressure. The luminous efficiency of the lamp varies with other conditions, but there is a certain ratio between vapor density and current at which the ratio of the light given out to the energy absorbed is a maximum. Other conditions may affect the behavior of the vapor column, but are not here considered. Thus, if the tube be placed in a magnetic field, the resistance of the vapor increases.

Value of the Work.

The study of electrical conduction through gases has been prosecuted vigorously under Dr. J. J. Thomson, and work on this subject has not only added greatly to our knowledge of electrical phenomena, but has probably done more to enlighten us as to the nature of matter itself than any other study. While Mr. Hewitt's work was carried out with mercury vapor alone, his results are, no doubt, general for all saturated vapors. His work is an important contribution to the knowledge on the subject and, at the same time, has a very practical bearing on the proper conditions to be secured in the mercury vapor lamp. To mention but one point: since there is a certain density for maximum luminous efficiency, lamps should be operated at this point. Lamps should then be constructed so that they will have this fixed relation between definite vapor density and current.

POWER FOR TRACTION IN A LARGE CITY.

An idea of the magnitude of electric railway development is given by an examination of the equipments of the power stations of Greater New York. The power obtainable from all the railway stations now in operation, at the nominal rating, is 142,170 kilowatts. This total does not include an additional 10,800 kilowatts in generators, about to be installed in one of the large stations, and 15,000 kilowatts in storage battery, which can be drawn on for one hour. In addition, one of the elevated systems has retained eighty steam locomotives, representing a total of about 11,400 kilowatts, for use during the season of heaviest traffic, because as yet it has been impossible to bring the equipment of the new generating station up to the requirements of a rapidly increasing traffic.

The Overload Rating.

Allowing an overload rating of forty per cent of the nominal rating of the power stations, the total power available for moving cars in this city to-day is 224,970 kilowatts, or nearly 300,000 horse-power. In addition to this, the new units already contracted for will give an additional output, at a nominal rating, of 10,800 kilowatts; and the nominal rating of the equipment at the power-house for the Rapid Transit system will be 50,000 kilowatts when completed. This will add to the total overload rating of 224,970 kilowatts, as given above, about 90,000 kilowatts; but, by the time all the new units are in operation, there will, undoubtedly, have been other additions in several of the older stations. The figures point to a minimum of 425,000 horse-power as the overload rating of the railway power stations of Greater New York in the near future. There is hardly a doubt but that it will greatly exceed this figure.

A METHOD FOR DETERMINING RATES AND PRICES FOR ELECTRIC POWER.[1]

BY FRANK B. PERRY.

1. That the future will show a rapid growth in the application of electricity to industrial pursuits, operated from a centrally located steam-driven electric power station, has led me to present the following data to our members, many of whom will doubtless find the methods suggested applicable to their own interests. The advent of driving textile and other mills from a plant of this character has opened a question for discussion as to the establishment of a proper basis for rates to be charged for electric current supplied in large quantities.

2. The contracts drawn up by electric companies with their customers sometimes contain a clause similar to the following, which is given for the purpose of illustration, and is not intended to cover any specific case: for a period of years from date the lessor agrees to furnish, and the lessee to receive and to pay for, within the times and on the terms set forth, all the power that may be required to properly operate and light his plant. The amount of power to be determined by meter readings, and to be billed monthly at the rates recited below, *viz.:*

1,800 to not more than 2,160 kilowatts at rate of $31.50 per kilowatt per annum.

More than 2,160 kilowatts and not exceeding 2,520 kilowatts at rate of $30 per kilowatt per annum.

More than 2,520 kilowatts and not exceeding 2,700 kilowatts at rate of $28.50 per kilowatt per annum.

All in excess of 2,700 kilowatts at rate of $27.60 per kilowatt per annum.

3. The above rates are based on an annum of 3,000 hours. From this schedule the following tables are derived:

TABLE I.

Rate per Kilowatt per Annum.	Equivalent Rate per Horse-Power per Annum.	Rate per Kilowatt per Hour.	Rate per Horse-Power per Hour.
$31.50	$23.499	$0.0105	$0.007833
30.00	22.38	0.0100	0.007460
28.50	21.261	0.0095	0.007087
27.30	20.5896	0.0092	0.006832

Table I is self-explanatory. An examination of table II shows plainly the faults that exist in a schedule such as that usually followed.

4. By using 2,161 kilowatts, or one additional kilowatt more than 2,160 kilowatts, a yearly saving of $3,210 may be made; similarly an increase of one kilowatt above 2,520 kilowatts effects a reduction of $3,751.50 per annum, and one extra kilowatt over 2,700 kilowatts lessens the yearly expense by $2,402.40.

TABLE II.

Kilowatts Used.	Cost per Annum.	Cost per Month.
1,800	$56,700.00	$4,725.00
2,160	68,040.00	5,670.00
2,161	64,830.00	5,402.05
2,268	68,040 00	5,670.00
2,520	75,600.00	6,300.00
2,521	71,848.50	5,987.37
2,652.7	75.601.95	6,300.16
2,700	76,950.00	6,412.05
2,701	74,547.06	6.212.30

5. While these figures show the points in the schedule at which the greatest saving may be made, many other qualities which are given in a later table illustrate equally well the irregularity of prices based on such a list of rates. The inconsistency of this method is further shown by the fact that 2,268 kilowatts cost the same as 2,160 kilowatts, or 108 kilowatts may be utilized without any increase in expense to the consumer. The price is also practically the same for 2,652.7 kilowatts as for 2,520 kilowatts, which indicates that any number of kilowatts between these limits may be used without additional cost to the person buying power.

6. It would appear from these figures that the electric company makes more profit at some places in the schedule than at others, and on that account could furnish certain amounts of power gratis. Of course, this is not true, but tends to convince one of the absurdity of the system that is customarily used by central electric stations. It is also evident that the customer, if he were so disposed, might watch his meter and so adjust his consumption of current as to bring about a substantial decrease in his bill for the month. For example, he might install a few extra machines that would not only serve to increase his product, but would also be the means of diminishing his bill. As an extreme case, the use of one additional kilowatt would bring about this result. It also might prove economical to burn electric lights during the day in order to increase the current consumption.

7. Both of these examples mentioned serve as illustrations of the fact that it is within the consumer's jurisdiction, by the terms of his agreement, to use power advantageously with a resultant financial loss to the electric company. While such a procedure may be perfectly legitimate, it would be fairer to all concerned to prevent contingencies of this kind from arising, and at the same time to provide a system of rates which would be to the mutual interests of both parties.

8. The horizontal lines on chart No. 1, Fig. 1, indicate the rates for power, and the diagonal lines represent the price per month for electric current covering the entire range of the above-mentioned schedule. The latter lines show at a glance the unfairness of the system, and prove conclusively that rates can not be adjusted properly on the customary basis.

9. The subsequent discussion is intended to give a method of rearranging a schedule of rates based on the "step-system," and for convenience the aforesaid figures will be used. The principles, however, may be applied to any other rates made up in a simlar manner.

10. Referring to table II and applying the well-known formula $(a + l)\frac{n}{2}$, giving the sum of the terms of an arithmetical progression we obtain for each step, assuming a common difference of one kilowatt, the following figures:

	Value of "a."	Value of "l."	Value of "n."
(1) 2,161—2,520 kw..	$64,830.00	$75,600	$360
(2) 2,521—2,700 kw..	71,848.05	76,950	180

11. The value of *"a,"* or the first term of the series represents the product of 2,161 kilowatts by its rate per kilowatt per annum. In a similar way the other terms of the series are obtained, *"l,"* indicating in each case the last term and *"n"* the number of terms.

12. Since the rate is constant from 1,800 to 2,160 kilowatts, we will compute simply the sum of the series beginning at 2,160 kilowatts.

Sum of (1) = (64,830 + 75,600) 180 = $25,277,400
" " (2) = (71,848.5 + 76,950) 90 = 13,391,865
1,160 kw. at $31.50 = 68,040
(3) Total sum of two series = $38,737,305

13. With a varying rate of power, diminishing in a fixed ratio between any two amounts, it is possible, by the substitution of proper quantities in an equation herein deduced by the writer, to compute the value of the sums of the product of each succeeding kilowatt by its corresponding rate.

14. The horizontal spaces of the charts, or abscissæ, represent in terms of kilowatts a progressive increase in each successive number by the addition of any desired equal amount.

Let (a) = first term. (l) = last term. (d) = common difference. (n) = number of terms. (s) = sum of terms.

[1] A paper presented at the New York meeting (December, 1903) of the American Society of Mechanical Engineers, and forming part of vol. xxv of the *Transactions.*

Then 1st term $= a$,
2d " $= a + d$,
3d " $= a + 2d$,
4th " $= a + 3d$,
$l = a + (n - l)d$,
$s = (a + l)\frac{n}{2}$.

15. The vertical spaces of charts, or ordinates, represent in terms of rates per kilowatt annum, or per kilowatt hour, a progressive decrease in each successive number by the subtraction of any chosen equal quantity.

Let (b) = first term. (k) = last term. (r) = common difference. (t) = sum of terms. (m) = number of terms.

Then 1st term $= b$,
2d " $= b - r$,
3d " $= b - 2r$,
4th " $= b - 3r$,
$k = b - (m - l)r$,
$t = (b + k)\frac{m}{2}$.

16. Multiplying the corresponding terms of these two series, we obtain the following:

(4) Product of 1st term $= ab$,
(5) " " 2d " $= (a + d)(b - r)$,
(6) " " 3d " $= (a + 2d)(b - 2r)$,
(7) " " 4th " $= (a + 3d)(b - 3r)$,
(8) " " last " $= \{a + n - l)d\}\{b - (m - l)r\}$.

17. Adding these products, and developing the quantities enclosed in parenthesis, we obtain for the sum of 1st and 2d term, designated (4) and (5).

(A) Sum of products 1st and 2d terms $= 2ab + bd - ar - dr$.

Multiplying equation by $\frac{2}{2} = \frac{4ab + 2bd - 2ar - 2dr}{2}$.

Substituting values $n = 2$ and $m = 2$ in the above, we find

$$(A) = \frac{2abn + bdn - arm - drm}{2}$$

$$= \frac{bn}{2}\left\{2a + (n - l)d\right\} - \frac{rm}{2}(a + d).$$

18. In a similar manner (B) = sum of (4), (5) and (6), and (C) = sum of (4), (5), (6) and (7),

$$(B) = \frac{bn}{2}\left\{2a + (n - l)d\right\} - \frac{rm}{2}(2a - 3\tfrac{1}{3}d),$$

$$(C) = \frac{bn}{2}\left\{2a + (n - l)d\right\} - \frac{rm}{2}(3a + 7d).$$

19. Comparing equations (A), (B) and (C), we find that they are alike in all respects excepting the coefficients of "a" and "d" of the negative terms.

20. Substituting these values, viz., for coefficient of "a" $(m - l)$, and for coefficient of "d"

$$\left\{\frac{2}{3}(m - 2) + l\right\}\left\{m - l,\right\}$$

we have for the sum of any number of products containing "n" and "m" terms.

$$\text{Total sum} = \frac{bn}{2}\left\{2a + (n - l)d\right\} - \frac{rm}{2}$$

$$\left\{a + \left[\frac{2}{3}(m - 2) + l\right]d\right\}\left\{m - l\right\}.$$

$$(D)\quad \text{Total sum} = \frac{bn}{2}(a + l) - \frac{rm\,(m - l)}{2}\left\{a + \frac{d}{3}(2m - l)\right\}.$$

21. In order to apply this formula to the case in question, let us consider the rate as beginning at \$31.50 per kilowatt per annum for 2,160 kilowatts and varying in amount to \$27.60 per kilowatt per annum for 2,700 kilowatts. By so doing, we preserve the limiting features of the schedule both for rates and for the quantities at which they are applicable. Since the successive steps in the first mentioned schedule show an even decrease in rate for equal increments of power up to 2,520 kilowatts, it is safe to assume that a list of rates may be made up to vary uniformly from 2,160 to 2,520 kilowatts and regularly, but at a different rate, from 2,520 to 2,700 kilowatts.

22. Let x = rate per kilowatt per annum for 2,520 kilowatts.

$a_1 = 2{,}160$	$a_2 = 2{,}521$
$b_1 = 31.50$	$b_2 = x$
$d_1 = 1$	$d_2 = 1$
$l_1 = 2{,}520$	$l_2 = 2{,}700$
$r_1 = \frac{(31.5 - x)}{360}$	$r_2 = \frac{(x - 27.6)}{180}$
$n_1 = 361$	$n_2 = 180$
$m_1 = 361$	$m_2 = 180$

23. Substituting these respective values in equation (D) gives

$$D_1 = \frac{31.5 \times 361}{2}(2{,}160 + 2{,}520) - \frac{(31.5 - x) \times 361 \times 360)}{2 \times 360}\ \{2{,}160 + \tfrac{1}{3}(722 - 1)\}$$

$$D_2 = \frac{180x}{2}(2{,}521 + 2{,}700) - \frac{(x - 27.6) \times 180 \times 179}{2 \times 180}\ \{2{,}521 + \tfrac{1}{3}(360 - 1)\}$$

From the above,

$$D_1 = \frac{159{,}655{,}860 - 81{,}886{,}171.5 + 2.590{,}561x}{6}$$

$$D_2 = \frac{2{,}819{,}340x - 1{,}418{,}038x + 39{,}137{,}848.8}{6}$$

24. Then in order to fulfil the conditions of the first-named schedule, $D_1 + D_2$ must equal (3) or

$$D_1 + D_2 = 38{,}737{,}305.$$

Substituting values of D_1 and D_2 and solving,

$$4{,}000{,}863x = 115{,}516{,}292.7$$
$$x = 28.872.$$

25. This value of "x" substituted in expressions for rates gives $r_1 = \$0.0073$ and $r_2 = \$0.00706\frac{2}{3}$ as the variations in charges for each kilowatt per annum from 2,160 to 2,520 kilowatts, and from 2,520 to 2,700 kilowatts respectively.

26. The rates per kilowatt-hour become $r_1 = \$0.0000024\frac{1}{3}$, $r_2 = \$0.0000023\frac{5}{9}$; for 30 kilowatt-hours, $r_1 = \$0.000073$ and $r_2 = \$0.0000706\frac{2}{3}$.

27. Using this system as a basis for rates, the wording of the agreement for power would be changed to read as follows:

"The charge for electric current furnished under this contract shall be made as per the chart attached hereto, and made a part hereof."

28. The line plotted on chart No. 2, Fig. 2, indicates the rates per kilowatt per annum which would, in this instance, replace the original schedule as given by chart No. 1, Fig. 1.

29. The results obtained by following these lines of rates necessarily gives, on account of the above reasoning, the same average price per month as that computed by the "step" system. Chart No. 3, Fig. 3, is an example of the form of chart which would be embodied in a contract for electric power in order to meet the rates outlined in the original agreement. It also gives an idea of the simplicity of interpreting rates and prices for power by making use of the scheme proposed.

30. Line No. 1 is drawn through points plotted in accordance with the rates specified on chart No. 2, Fig. 2; the ordinates being equal to rates per kilowatt-hour and the abscissæ representing kilowatts. From 1,800 kilowatts to 2,160 kilowatts and above 2,700 kilowatts the rate is constant at \$0.0105 and \$0.0092 per kilowatt-hour as respectively indicated by the horizontal portions of the line. From 2,160 to 2,520 kilowatts the rate diminishes in a fixed

ratio for each additional kilowatt used, namely, from $0.0105 to $0.010062 per kilowatt-hour; also from 2,520 to 2,700 kilowatts the rate diminishes uniformly,

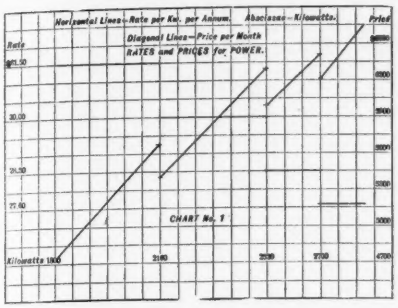


FIG. 1.—RATES AND PRICES FOR ELECTRIC POWER.

but not so rapidly as between the points previously stated, from $0.010062 to $0.0092 per kilowatt-hour. It will be noted that the ordinates may be read easily to one one-thousandth of a cent per kilowatt-hour and the abscissæ to three kilowatts without estimating fractional division of the spaces.

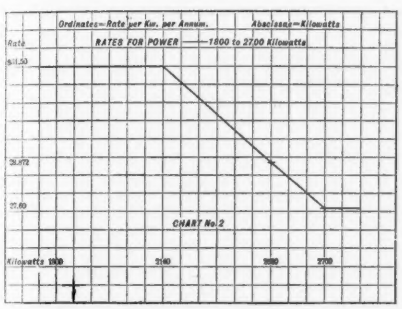


FIG. 2.—RATES AND PRICES FOR ELECTRIC POWER.

31. Line No. 2 is deduced from the foregoing, and by its means one may determine at a glance, knowing the wattmeter reading, the amount of each month's bill for power consumed.

32. The lower line of figures on the chart represents meter readings in kilo-

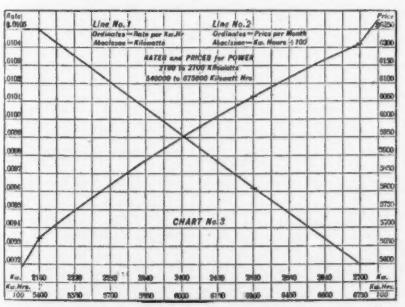


FIG. 3.—RATES AND PRICES FOR ELECTRIC POWER.

watt-hours divided by one hundred. These quantities are computed by multiplying the kilowatt readings by 250, the average hours per month, of one-twelfth the total for the year as limited by the contract. Two ciphers are omitted from these results to avoid repetition of figures. To obtain the bill per month, find the number on charts corresponding to that recorded by the wattmeter, and note the point vertically over same on line No. 2. In the column at the right-hand side of the chart, horizontally opposite this intersection, will be found the price of bill for the amount of power in question. The abscissæ may be read accurately to 750

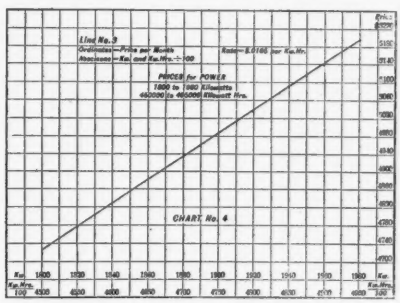


FIG. 4.—RATES AND PRICES FOR ELECTRIC POWER.

kilowatt-hours and the ordinates to $5 for the corresponding spaces, and by estimation of tenths these differences may be proportionately reduced.

33. Charts No. 4 to No. 8 (Figs. 4 to 8) inclusive are similar to, and may be considered as supplementary to chart No. 3. Each chart includes a section of 180 kilowatts of one-fifth of the entire range from 1,800 to 2,700 kilowatts.

34. Lines No. 3 and No. 4 indicate prices for power up to and including 2,160

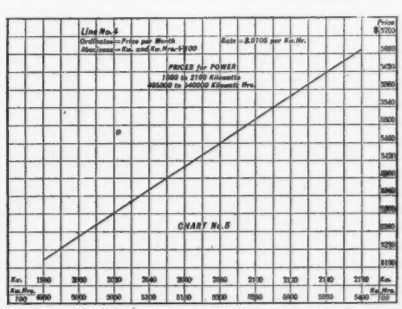


FIG. 5.—RATES AND PRICES FOR ELECTRIC POWER.

kilowatts at a constant rate of $31.50 per kilowatt per annum, or $0.0105 per kilowatt-hour. Lines No. 5, No. 7 and No. 9 represent rates

varying respectively from	$31.50	to	$30.186	per kw. p. an.	
" " "	30.186	"	28.872	"	"
" " "	28.872	"	27.60	"	"
or from	$0.0105	to	$0.010062	"	" hr.
	0.010062	"	0.009624	"	" "
	0.009624	"	0.0092	"	" "

35. Lines No. 6, No. 8 and No. 10 show prices per month for power, varying in the order given from 2,160 to 2,340 kilo-

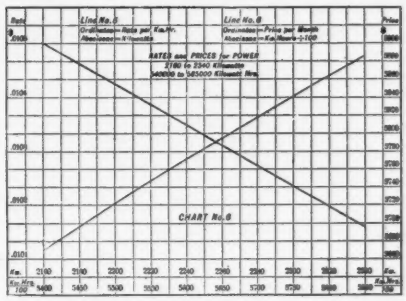


FIG. 6.—RATES AND PRICES FOR ELECTRIC POWER.

watts, from 2,340 to 2,520 kilowatts and from 2,520 to 2,700 kilowatts. Each of the spaces on the charts No. 4 to No. 8 inclusive occupied by the abscissæ repre-

sents one kilowatt or 250 kilowatt-hours as the case may be, consequently are well within the limit that it is possible to read a recording wattmeter of 3,000 kilowatts capacity.

36. Greater accuracy is also attainable in determination of rates per kilowatt-hour or the total bill for the month.

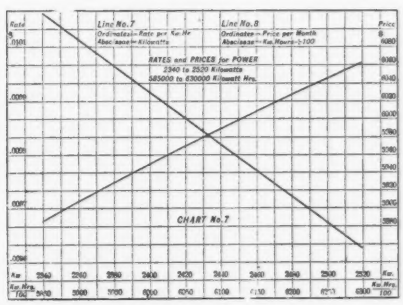


FIG. 7.—RATES AND PRICES FOR ELECTRIC POWER.

This may be carried to a still further degree of refinement by an increased subdivision of the amounts of power and their accompanying rates. The principles enumerated may be applied equally well to a given list of powers with any predetermined rates. The table III is pre-

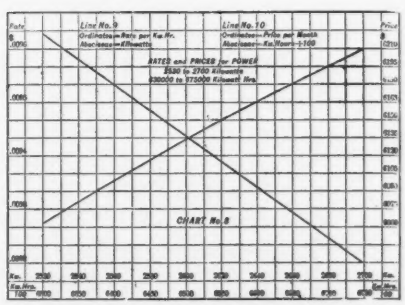


FIG. 8.—RATES AND PRICES FOR ELECTRIC POWER.

sented to show the comparison of prices per month that would be paid for various amounts of power by the original agree-

ment, and also by the lines illustrated on charts No. 3 to No. 8 inclusive (Fig. 3 to 8).

37. Referring to the tabulation, one may observe that between 2,190 and 2,370 kilowatts, the chart gives figures higher than the schedule, while from 2,370 to 2,520 kilowatts the monthly bills are lower. As previously stated above, the average is practically the same. The last line of the table shows that for the points taken the discrepancy between the chart and the schedule amounts to about three hundred and forty-seven-one-thousandth of one per cent. This difference would be lessened by choosing smaller subdivisions and would finally amount to zero when the points are taken at one-kilowatt intervals. Of course, if the meter should indicate a use, say, of 2,520 kilowatts per month considerably more would be paid to the central station by the chart system than by the schedule. It is equally true that there are points on the chart lines where, if the meter should read the proper amount, the bill would be less than by the schedule.

TABLE III

Equivalent Horse-Power.	Kilowatts.	Kilowatt Hours per Month of 250 Hours.	Rate per Kilowatt Hour.	Monthly Bill. By Chart.	Monthly Bill. By Schedule.	Difference.
2,894.1	2,160	540,000	$0.0105	$5,670.00	$5,670.00	— .....
2,935.7	2,190	547,500	.010127	5,708.78	5,475.00	— $233.78
2,977.2	2,220	555,000	.010354	5,746.47	5,550.00	— 196.47
3,016.1	2,250	562,500	.010281	5,783.06	5,625.00	— 158.06
3,056.3	2,280	570,000	.010208	5.818.56	5,700.00	— 118.56
3.096.5	2,310	577,500	.010135	5,852.96	5,775.00	— 77.96
3,136.7	2,340	585,000	.010062	3.886 27	5,850.00	— 36.27
3,176.9	2 370	592,500	.008989	5,918.48	5,925.00	+ 6.52
3,217.2	2,400	600,000	.009916	5,949.60	6,000 00	+ 50.40
3,257.4	2,430	607,500	.009843	5.979.62	6,075.00	+ 95.38
3,297.6	2;460	615,000	.00977	6 008.55	6,150.00	+ 141 45
3.337.8	2,490	622.500	.009697	6,036.38	6,225.00	+ 188.62
3,378.0	2 520	630,000	.0096241/3	6,063.12	6.300.00	+ 236.88
3,418.2	2,550	637,500	.0095533 1/3	6,090.25	6,056.25	— 34.00
3,458.4	2,580	645.000	.0094826 2/3	6.116.32	6,127.50	+ 11.18
3,498.6	2,610	652,500	.009412	6,141.33	6,198.75	+ 57.42
3,538.8	2,640	660,000	.0093413 1/3	6 165.28	6 270.00	+ 104.72
3,579.1	2,670	667,500	.0092706 2/3	6,188.17	6,341.25	+ 153.08
3,619.3	2 700	675,000	.0092	6.210.00	6,412.50	+ 202.50
Total.....				$113,333.20	$113,726.25	— $393.05

38. The convenience of this method in determining the value of bills rendered each month should be appreciated both by the electric company and by the user of current. There is no conflicting of rates or prices with such a system, and bills increase gradually and consistently, as they ought, in proportion to the amount of power used. This method, which is equally fair to producer and to consumer has, to the best of my knowledge, not been used up to the present time by any central electric station for finding costs of current where varying rates per kilowatt annum or per kilowatt-hour are involved.

39. These ideas are submitted with the belief that their adoption will bring about more satisfactory results than can ever be realized by a continuance of the so-called "step" system of rates.

The Testing of Electric Generators by Air Calorimetry.

At the meeting of the British Institution of Electrical Engineers, held November 26, a paper was read by Mr. Richard Threlfall, describing a calorimetric method of testing generators, which he had devised and used with much success. The method was devised in order to test a generator which was so situated that it could not be coupled up to another machine and tested by the Hopkinson method. Mr. Threlfall's method consists in enclosing the generator in an air-tight case, which is protected against leakage of heat, and through which a steady stream of air of known volume is forced. Knowing the quantity of air passed, its humidity and density, and the rise in temperature, the losses in the generator are easily computed, as they are taken up as heat by the air. One advantage of the method is, that the losses are measured directly, and, since they constitute, for a generator of medium or large size, not more than ten per cent of the full load output, a considerable error in their measurement will cause but a small error in the figure deduced for the efficiency.

In applying this method, the first difficulty lies in determining accurately the quantity of air passed through the casing. It was fully determined that a Pitot tube gave the most satisfactory results. This is a tube extending into the air duct, with an opening directed against the stream of air. The tube is U-shaped, the other extremity being let into the tube with a flanged mouth. The U part of the tube is filled with water, and the difference in the level of the two legs of the tube is directly proportional to the velocity of the air at the intake of the tube. It is necessary to determine the rate of flow in all portions of the tube, but, having done this, a position can be found which gives the mean value, and it was ascertained that this position does not change with different rates of flow.

To protect the casing against loss or absorption of heat from external sources, the mean temperature of the air at the intake and the outlet, is maintained equal to that of the external air. The casing is also lined with silver paper to make it air-tight and this is also a good heat insulator. In places it is lined with felt. The apparatus was tested by placing within the casing, resistance strips, and expending in these a known amount of energy. The quantity measured by the calorimetric method agreed closely with that shown by the electrical instruments. The machine tested was rated at 300 kilowatts. Its efficiency was found to be eighty-nine per cent. It was driven by a two-cylinder tandem gas engine, and, after the efficiency of the apparatus as a generator has been determined, it was used as a brake to test the gas engine, the following being the results of this test: The gross total indicated horse-power was 517; absorbed in pumping and friction at no load, seventy horse-power, giving a mechanical efficiency of 86.5 per cent. The mean power was 301.42 kilowatts, and the efficiency of the dynamo was 88.93, showing that 338.9 kilowatts were delivered by the engine. The indicated kilowatts were 385.75, and the resulting mechanical efficiency was 87.86. These figures, the author believes, are the most reliable that have yet been obtained for a gas engine of this size.

Radium Industry.

Consul-General Richard Guenther, at Frankfort, Germany, reports that notwithstanding the difficulty in its production (many tons of ore being required to produce one gramme) a radium industry has already developed in Germany and France, and although one gramme is sold at a little less than $2,000 the manufacturers are said to have orders for several hundred grammes.

The demand for medical purposes exceeds the supply. Radium possesses all the important qualities of the Rœntgen rays, in addition to the invaluable property of being ready for use at any time and furnishing its rays without the employment of apparatus.

The fact that radium exerts a very peculiar influence upon light-emitting bodies has given rise to the hope that it may eventually play an important rôle in the industry of light. A minute quantity of radium is sufficient to produce a strong light from a layer of zinc pyrites.

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY.

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

The Nickel Refining Industry and Its Prospects.

In a note on nickel production in Canada published in the issue of the ELECTRICAL REVIEW for January 31, 1903, the writer referred to the plans for erecting an electrolytic refining works at Sault Ste. Marie, for treatment of the copper-nickel matte obtained from the Canadian ores, and to the absence of reliable information relative to the process which was to be employed at this refinery. Ulke in an article on the electrolytic nickel refining industry, recently published in an American contemporary, has referred to the proposed works at Sault Ste. Marie, but since he has not given the definite information required, it is evident that the process to be used at this refinery is not yet settled. Ulke recommends a combination of his own patented process and of Thum's for the mattes to be treated; and it will be interesting to note whether his recommendation will be adopted.

The prospects of the various nickel companies are undoubtedly improving, for nickel-steel is coming more and more into use, especially for railway purposes. It is doubtful, however, whether this increased consumption of nickel will require any large adoption of electrolytic processes for refining the crude nickel. Ulke, in the article referred to, has pointed out that the managers of the Orford Copper and Nickel Company, one of the oldest producing companies, have learned how to obtain nickel testing 99.2 per cent by the ordinary metallurgical process, and that in consequence they have ceased to send the raw metal for electrolytic treatment by the Balbach company. It would seem probable, therefore, that the bulk of the nickel which will find its way into the iron and steel industries will not be submitted to electrolytic treatment for removal of the last traces of impurity—especially as these impurities would not be chiefly silver and gold, and so pay for the cost of the refining operation, as in the copper industry. Electrolytic refining in the nickel industry is therefore likely to be reserved for metal intended for special uses, in which the cost of the metal is of secondary consideration. It is interesting to note in this connection that Johnson has recently published details of a research relating to the deposition of thick plates of nickel. His experiments have proved that one important condition is to have a gas free electrolyte, and by passing his solutions through a vacuum apparatus he has been enabled to obtain this condition of success. The explanation is, that the hydrogen which otherwise would be occluded by the deposited metal is dissolved by the electrolyte. The process has been patented.

Water Power Centres in Italy.

A greater development of water power for electrochemical and electrometallurgical purposes has occurred in Italy during the last three years than in any other European country. Fuel is scarce in that country, and its cost is therefore high. The prospects for central water power stations, especially in the North where water power is plentiful, are good, and it is in the northern districts that such a development has recently been occurring with the aid of French and German capital. As pointed out by the writer in a recent note upon the progress of similar undertakings in America however, there is a general tendency for financiers to underestimate the capital required, to bring such developments to a successful issue; and Italy has not escaped the troubles caused by this miscalculation on the part of the promoters. The Italian Electrochemical Company owns two water power concessions in the northern provinces; one at Bussi, on the river Ticino, being rated at 6,000 horse-power; and the other on the R. Pescara, at 38,000 horse-power. The original capital of the company was $1,300,000, but this has proved insufficient to develop both the concessions, and so far only the water power at Bussi has been dealt with. Caustic alkalies and bleach were produced at this place. Owing to various causes, the company has lost heavily, and it has become necessary to write down the value of the original share-capital by forty per cent; to issue new shares to the extent of $540,000; and to convert its floating debt of $550,000 into a bond issue of like amount. The Franco-Swiss company for electrical undertakings was financially interested in this company, and is reported to have lost $160,000 in consequence of the depreciation in the value of its shares. In spite of this unfortunate setback to the prosperity of one of the larger power companies in the north of Italy, Dr. A. Bolis, who has written on this subject in the *Chemiker Zeitung*, considers the prospects in Italy are good for electrochemical and electrometallurical undertakings; and that with greater attention to both the scientific and financial sides of the business, the Italian water power schemes and subsidiary industries will eventually pay those who have been bold enough to sink capital in them in these early days of their development. As evidence of the growth of the industries, Dr. Bolis states that since 1897 eleven electrochemical companies have been founded in Italy, with a total capitalization of $6,000,000.

Aluminum in the United States and Canada.

The 15,000 horse-power (see ELECTRICAL REVIEW of February 7, 1903) now being applied to the electrolytic extraction of aluminum from bauxite and alumina at the three works situated in America, has not so far had any very marked effect upon the production figures, but possibly the returns for 1903 will show a largely increased output. The figures for the production of aluminum in America during the past five years have been as follows:

	Pounds.
1898	5,200,000
1899	6,500,000
1900	7,150,000
1901	7,150,000
1902	7,200,000

There is a proposal to float a new company for production of the light metal in Canada, and a bill with this object in view has been passed through the New Brunswick Legislative Assembly. The title of the new company is the Aluminum Production Company of New Brunswick; and a capital of $6,000,000 is to be raised for erection of an aluminum reduction works at the Grand Lake coalfields, in Queen's County. The promoters of this company are interested in the manufacture of McAdamite, an alloy containing aluminum as chief ingredient. I am unable to say what process the promoters of the new company intend to use, but possibly they have in mind the fact that the various original aluminum extraction patents have only a few more years to run before they lapse. The manufacture of aluminum will, therefore, soon be an open industry.

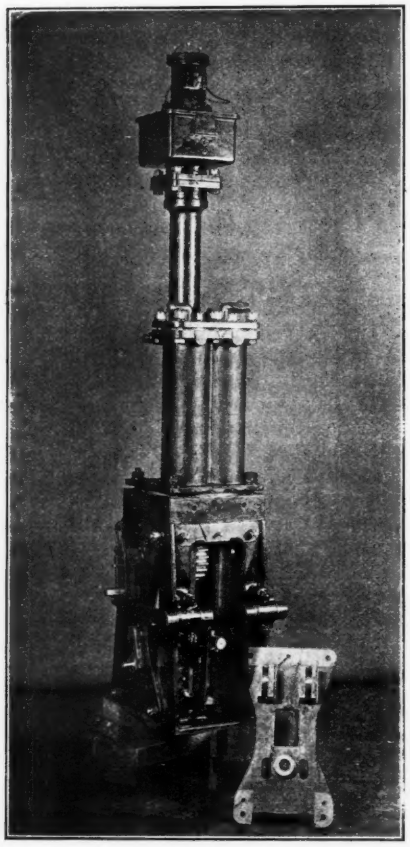
As regards the applications of aluminum, its utilization for bare overhead transmission lines and for printing purposes seems at present to be developing most rapidly. The latter use has extended to the United Kingdom, and many of the leading lithographic firms are now employing rotary aluminum presses for high-class poster work. The Aluminum Rotary Press Company has opened an office in London, and in a recently issued catalogue it states that eighteen British firms are now regularly using its presses for printing color work.

After a long fight, aluminum has therefore gained a permanent footing in the printing world. As the plates used in these presses can be employed repeatedly, this application of the metal can, however, add very little to the annual consumption, expressed in tons.

The Siemens-Schückert Multiple Unit System of Electric Train Control.

By Emile Guarini.

THE more electric traction develops, the greater are the efforts made by technical men to bring it to perfection and render its superiority over steam traction ever more conspicuous. One of the greatest advantages of electricity is, that it gives more elasticity to the traffic by permitting the economical running of a considerable number of light trains instead of a limited number of heavy ones. As the amount of goods and the number of passengers to be transported are not constant, it is evident that the weight of the train and the number of cars will vary according to the circumstances. The motor of the locomotive must, therefore, be capable of working under variable loads, sometimes above and sometimes below the normal, with fair efficiency. And what is more, when the power is centralized in a single locomotive, whose useful adhesive weight—that is to say, tractive power at the wheel—is only one-sixth of the total weight, an addition to the train of cars which need for themselves, for example, a force of 300 kilogrammes each, requires the locomotive to have a surplus weight of as many times two tons as cars are to be added. The multiple motor system, on the other hand, makes it possible, when an addition of cars is suddenly necessitated by any particular circumstance, to add at the same time the necessary supplementary motor, which is mounted on the car itself, and that without any relative increase of the useful dead weight.



OPERATING AND REVERSING CYLINDERS—SIEMENS-SCHÜCKERT SYSTEM OF MULTIPLE UNIT CONTROL—BACK VIEW.

INTERIOR OF MOTORMAN'S CAB, SHOWING MASTER CONTROLLER OF THE SIEMENS-SCHÜCKERT SYSTEM OF MULTIPLE UNIT CONTROL.

Until now there were known two multiple unit systems of electric train control: first, that of Sprague, which is exploited by the General Electric Company, and that of the Westinghouse Electric and Manufacturing Company. The former is entirely electrical; the latter is operated entirely by compressed air.

To these two there has just been added the Siemens-Schückert system, which is the result of long and painstaking experiments, justified by the serious disadvantages which, according to this firm, the two other systems possess. Thus in the purely electrical method of control, as the Siemens-Schückert Company states, the drawbacks are the difficulty of employing small motors for reversal of direction with pressures of 800 volts and over, the enormous dimensions and weight (up to 1,000 kilogrammes) of the traction magnets, the rise of self-induction, violent sparking at the distribution line, the inconvenience of looking after the bearings and brushes of the motors, etc. In the system of control by compressed air, pure and simple, which it otherwise admits to possess serious advantages, it objects to the large number of

parts, frequent refusals to operate, the absence of dependence for power on the motor current and of well-defined main positions for the interrupters, etc. In view of the great superiority which it recognizes in the control by compressed air and in order to overcome the disadvantages cited above, the Siemens-Schückert Company has devised a mixed system, in which electricity serves only for the operation of compressed-air valves. This system, after having been practically tried on the Gross-Lichterfelde experimental line, has recently been installed on the underground line at Berlin.

Compressed air has been adopted for the actual operation of the controllers, the pneumatic valves being actuated by a low-voltage current. Two separate controllers, namely, a reversing and a speed controller, are under the control of the motorman. The speed controller has two main positions, one for putting the motors in series, the other for putting them in parallel. In order to ensure the immediate interruption of the circuit in case the train parts, the current actuating the valves flows all the time, while the train is in motion. The interruption of the current for any reason disconnects the motors from the circuit.

The following considerations have prevailed in the development of this system:

1. The number of parts must be very limited.

2. The controllers must be of the ordinary type, which have stood practical trial.

3. The speed controller must have two main positions—"in series," for half speed; "in parallel," for full speed. It must be able to occupy intermediate positions.

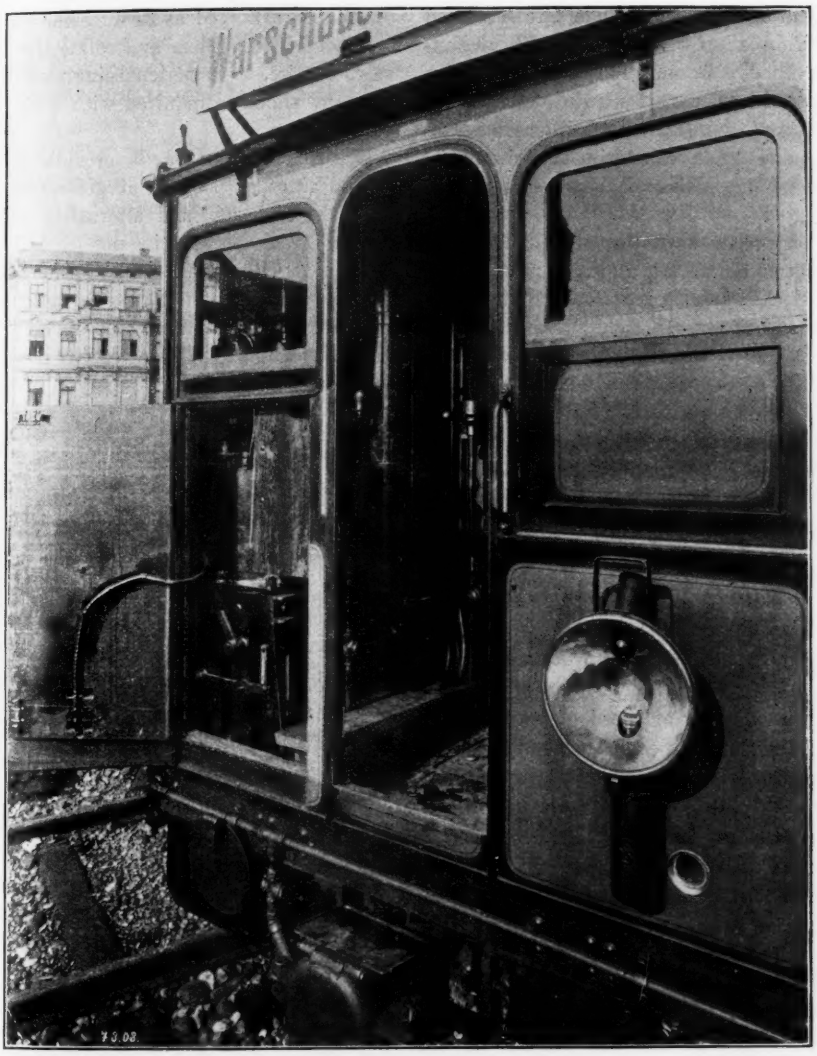
4. Direct current is to be employed, so that the breaking of the circuit may be effected by interrupting the line current.

5. The management must not require any skill. A wrong manipulation must not entail any bad consequences.

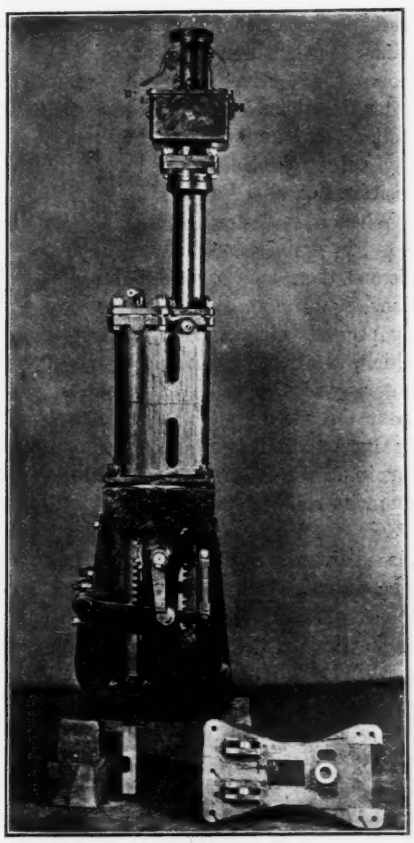
The accompanying illustrations relate to the Siemens-Schückert system. One shows the front of a train equipped with this system; the interior of the motorman's cab may be distinguished in it; another shows the interior of the cab, alongside of the controller there is visible a set of cylinders, the object of which will be explained presently; two others show this set of cylinders in two different positions.

The complete apparatus comprises, besides the motorman's switch, two relays which operate the valves, letting the compressed air into the two cylinders, whose piston rods may act (1) on the reversing controller; (2) on the piston rod of a third cylinder which is always under air pressure. The rod of this latter piston is a toothed rack geared with the speed controller.

Supposing now that the motorman puts the controller handle in the position "series-forward" *b;* this action has the effect of operating one of the relays which, by attracting its armature, opens the valve that lets compressed air into one of the cylinders; the piston of the latter moves forward, acts on the reversing con-



FRONT OF CAR EQUIPPED WITH SIEMENS-SCHÜCKERT SYSTEM OF MULTIPLE UNIT CONTROL—SHOWING APPARATUS IN MOTORMAN'S CAB.



OPERATING AND REVERSING CYLINDERS—SIEMENS-SCHÜCKERT SYSTEM OF MULTIPLE UNIT CONTROL—FRONT VIEW.

troller, the position of which it fixes, and pushes the toothed rod of the third piston. By its motion this piston disengages the speed controller, which is arrested at a certain point by a ratchet. The attendant may, however, stop the movement at any desired point by placing the handle in the position "series-forward" *a*.

The motors are now in series and half speed is obtained. To reach full speed the motorman moves the handle to the position "parallel-forward" *b*. This has the effect of actuating the second relay which, in operating a valve, causes the admission of compressed air into the second cylinder. The piston of the latter advances, adjusts the reversing controller, frees the rack from the ratchet that retains it (as has been explained above) and moves the toothed rack forward. The latter, in advancing, turns the speed controller. Its motion may be stopped at any point by placing the handle in the position "parallel-forward" *a*.

When it is desired to stop, the handle is put in the position "off." The first two pistons then take up their initial positions, again moved by the pressure of the compressed air in the third cylinder which, as already stated, is always under pressure. In going back the toothed rack turns the speed controller backward, and finally the first two piston rods, in returning, make the reversing controller resume its original position.

For running backward the handle is placed in the position "series-back" *b*. The second relay is then operated and the compressed air admitted to the second cylinder; the reversing controller is moved to the position "back," but the speed controller works in the same manner as before. In running backward the motors can not be coupled in parallel. The connections "parallel-back" may be used, if necessary, as a brake; in this case, as also in the former ones, an automatic circuit-breaker protects the machinery against excessive currents.

The apparatus located on the trains and shown in the illustrations, although identical in principles, is not absolutely so in construction. It has been found necessary to take into consideration in the design the limitations of the space at disposal, and for the purpose of economizing it the first two cylinders are placed side by side, and the above summarily described construction of the reversing controller and other organs of this part has been replaced by a combination of gears and pinions, of which an idea may be formed from the illustration. The contacts of the speed controller are provided with powerful magnetic spark blow-outs. Provisions have likewise been made for rapidly disconnecting either motor from the circuit; in such a case the car is run by one single motor.

For the sake of clearness, no mention has been made of several accessory organs, the necessity for which has been felt in practice. Thus the movements of the piston of the third cylinder are regulated by the play of a fourth piston in a cylinder filled with oil. This oil flows into a reservoir or runs back into the cylinder by the operation of different valves actuated by a relay, in the circuit of which the automatic circuit-breaker is inserted.

The trials have proved that the Siemens & Schückert multiple unit system of electric traction attains a high degree of perfection. It combines all the advantages of electrical transmission and retains at the same time all those of control by compressed air. It overcomes in this manner the disadvantages inherent in compressed air conduits and the multiplicity of electrical conductors required by other systems.

Rapid Submarine Cabling.

According to the London *Electrician,* recent cricket matches in Australia have been the means of giving much publicity to the question of speed of transmission on the submarine cables between England and that country. The two systems are owned, respectively, by the Eastern and the Eastern Extension Telegraph companies, and the Pacific Cable Board, and the following is the schedule of times occupied by the two routes in transmitting the accounts of the match from New South Wales. On Friday, November 20, the Eastern route occupied nineteen minutes, as against seventeen minutes on the Pacific cable. On Saturday, November 21, the Pacific cable took fifty minutes to get through, as against twelve by the Eastern. On Monday, November 23, the Eastern got the result of the match over in fifteen minutes, whereas the Pacific took only eleven minutes. In order to get these messages through, the whole route had to be cleared.

Turbine Operated with Gas Engine Exhaust.

A British patent has been obtained by Mr. F. W. Lanchester, of Birmingham, England, having for its object to provide an improved construction of turbine suitable for employment on the exhaust of an internal combustion engine, for utilizing the residual pressure. This turbine is described in the November 28th issue of the *Mechanical Engineer,* London. It is specially designed to permit the employment of gases at variable temperatures. The working parts of the turbine consist primarily of a pair of fixed and revolvable discs containing pockets of curvilinear outline, so arranged as to force the gases to react between them and rotate the revolvable disc, the reaction being repeated as many times as required with a single pair of discs.

The rotating disc may be provided with several rings of pockets, at greater radii than the first one, and alternating with similar guide pockets in the fixed disc. This construction allows a greater expansion of the gases. If the temperature of the gases is very high, the amount of the disc occupied by the actuating nozzles is a very small angular proportion of the whole disc. A relatively large cooling period is thus provided.

Electrical Section of the Canadian Society of Civil Engineers.

The second meeting of the Electrical Section of the Canadian Society of Civil Engineers was held recently in Montreal. President R. B. Owens was in the chair.

The first paper was by Mr. P. M. Lincoln, of Pittsburg, and discussed the Westinghouse single-phase traction system, comparing it with direct-current systems. Particular reference was made to the Washington, Baltimore & Annapolis Electric Railway.

Mr. A. H. Armstrong, of Schenectady, read a paper which compared steam and electric methods for heavy railroad work.

Mr. Lincoln gave careful estimates of costs of both the construction and operation, which showed a substantial advantage in favor of the alternating-current system in the ideal case taken, which was a line sixty miles long, with power station centrally located, transmission to substations at 20,000 volts, and trolley voltage of 3,000, reduced on the cars to a suitably low voltage. The proper starting effect was secured by lowering the voltage applied to the motors.

Mr. Armstrong's paper showed that a saving could be effected by the application of electric motive power to heavy trains of 1,000 and 1,500 tons.

Professor L. A. Herdt read a paper describing the polyphase equipments of European high-speed electric railways.

INTERURBAN ELECTRIC TRACTION SYSTEMS.[1]

COMPARISON OF ALTERNATING AND DIRECT-CURRENT SYSTEMS.

BY P. M. LINCOLN.

Practically all the traction work in America has been done by direct current. American engineers have consistently refused to adopt the polyphase induction motor for traction purposes on the ground that it is not suitable for that purpose. The principal reasons for this stand are two in number:

(1) That the polyphase induction motor is inherently a constant-speed motor and therefore not adapted to traction purposes. Continual change of speed is one of the characteristics of traction work.

(2) The second reason against the use of polyphase induction motors for traction purposes is the necessity for providing at least two overhead conductors. Maintenance of insulation on such overhead conductors when they are at high voltage is naturally a difficult problem, much more difficult than to maintain the insulation between a single conductor and ground, as would be the case in the single-phase system.

American engineers, instead of endeavoring to adapt the unsuitable induction motor to traction purposes, have devoted their energies to the development of a suitable alternating-current motor. The only alternating-current single-phase motors which have a characteristic suitable for electric traction purposes are those of the commutator type. In no other type of motor are the speed and torque characteristics such as to be suitable for traction purposes.

The principal advantages of the alternating current electric traction over the direct-current are as follows:

(1) Limits to trolley voltage are removed.

(2) Avoidance of rheostatic losses.

(3) The necessity for rotary converter substations abolished.

(4) Manual attendance at the substations done away with.

(5) Danger of electrolysis by return current avoided.

To take up these points more in detail:

(1) *Voltage Limit Removed*—Six hundred volts at the motor in a direct-current traction system is practically the limit at which present designers and manufacturers are willing to guarantee their operation except in some special cases. The alternating-current system, providing the possibility of greatly increasing the voltage of the distributing system, thus cuts down largely the cost of this distributing system.

In addition, by raising the voltage of the secondary system, the current taken by a locomotive may be reduced and consequently the difficulty with collecting devices may be made to disappear.

(2) *Rheostatic Losses Avoided*—With the alternating-current system, on the other hand, the voltage at the car may be controlled by suitable means and rheostatic loss thus avoided.

(3) *Necessity for Rotary Converters Avoided*—In the alternating-current equipment the rotary converter has no place, thus avoiding not only a large item of cost of substations, but also one of the largest items of the loss of power.

(4) *Attendance at Substations Done Away with*—Alternating-current substations consist of static transformers only. Making the switching devices entirely automatic in their operation avoids the necessity of attendance for this purpose.

(5) *Electrolysis*—Electrolysis of parallel conducting systems is generally recognized as one of the most serious dangers in connection with present direct-current trolley systems, and the fact that an alternating-current system avoids this danger entirely need only be mentioned in order to be recognized as a marked advantage.

The disadvantages which necessarily accompany the use of the alternating-current traction system are as follows:

(1) Additional weight.

(2) Difficulty of operating on existing lines.

(3) Increased rail loss.

(4) The fact that an active electromotive force exists between field turns.

(5) Possible interference with telephones.

(1) *Additional Weight*—An alternating-current motor of a given capacity is necessarily somewhat heavier and somewhat more expensive than a direct-current motor for the same capacity. Further, in order to make use of the advantages of high trolley voltage, the alternating-current equipment should preferably be provided with a step-down transformer on the car. Also, in order to obtain the advantages of avoiding rheostatic losses, some provision must be made for controlling the voltage on the car. The transformer, the voltage control apparatus and the greater weight of the motors make the alternating-current equipment necessarily heavier than the direct-current.

(2) *Difficulty of Operating on Existing Lines*—Practically all interurban roads run through cities on existing tracks and must therefore use the existing sources of direct-current power. In order to meet this condition, the equipment for an alternating-current interurban road must be so arranged as to operate on alternating current outside the city and on direct current inside. Although this is entirely possible, it must necessarily prove to be a matter of considerable complication. The most important part of the equipment—the motors—can be operated from direct as well as alternating current.

(3) *Increased Rail Loss*—Experiments have shown that with alternating current from 2,000 to 3,000 alternations, the actual loss which takes place with a given current through the iron rails is from three to five times that which the same direct current would give. But when it is considered that in order to utilize the main benefit of the alternating current, a higher trolley voltage is used and, therefore, smaller currents in the return conductor, the element of rail loss in an alternating-current proposition may be made even a smaller proportion of the total than in the direct current, in spite of this apparently large handicap.

(4) *Active Electromotive Force Between Field-Turns*—The space that can be assigned to the motor for operating a car is necessarily limited. When we consider the alternating-current motor, the question of space available becomes still more exacting, first, because the alternating-current motor is necessarily heavier and therefore occupies more space than an equivalent direct-current motor; and, second, because between field-turns of the alternating-current motor there is an active electromotive force similar to that between the turns of a transformer winding. A short-circuit between field-turns in an alternating-current motor, therefore, means a destructive short-circuit and an immediate interruption of service from that motor. As an offset against this disadvantage of an active electromotive force between field-turns, the alternating-current motor possesses the advantage of being capable of operation at low voltage, thereby reducing the number of turns on the series field and increasing the proportionate space for insulation. The use of a step-down transformer on the car makes available any desired voltage at the motor.

(5) *Interference with Telephones*—It

[1] Abstract of paper read at recent meeting of the electrical section of the Canadian Society of Civil Engineers, Montreal.

DIRECT-CURRENT RAILWAY SYSTEM.

POWER REQUIREMENTS.

Average K.W. at car in typical 2-mile run (Fig. 1)	67.2	K.W.
No. cars running at one time	8	
No. substations	5	
Average No. cars per substation	1.6	
$\sqrt{\text{Mean}^2}$ amps. per car	185.3	
$\sqrt{\text{Mean}^2}$ amps. per substation $= m$	279.0	
With substations 12 miles apart, 80 lbs. track rail and 60 lbs. 3d rail, resistance between adjacent substations is $= r$	0.9	ohm
D. C. line loss per substation $\frac{r\,m^2}{6} =$	16.1	K.W.
Average K.W. per substation at cars $= 67.2 \times 1.6 =$	107.5	
Average K.W. per substation at substation	123.6	K.W.
Per cent loss in 3d rail	15.5	per cent
Per cent loss in step-down transformers	3.5	per cent
Per cent loss in rotaries	10.0	per cent
Per cent loss in high tension line	2.5	per cent
Per cent loss in step-up transformers	3.5	per cent
Total per cent loss from cars to P.-H.	39.5	per cent
Average K.W. consumed by 8 cars at the cars	537	K.W.
Average K.W. at power-house for 8 cars	750	K.W.
Max. load per substation—worst condition, 2 cars starting	560	K.W.
One 400 K.W. rotary will take care of this 40 per cent overload.		
Average load on rotary	30	per cent
Rotary substations are of sufficient size so that one can be cut out temporarily.		
Max. load on P.-H., say	1,200	K.W.
Can be taken care of with three 400 K.W. generators—one for spare.		

STEP-UP TRANSFORMERS.

Seven 150 K.W. transformers—one for spare.

HIGH-TENSION LINE.

One No. 6 B. & S. gauge line each way from P.-H. 20,000 volt, 3-ph.		
Max. loss, about	8.25	per cent
Aver. loss, about	2.50	per cent

SUBSTATION EQUIPMENT.

5 substations in all. 1 in P.-H.
Each of 4 substations to contain:
- Three 135 K.W. step-down transformers
- One 400 K.W. rotary converter.
- Switchboard.
- Step-down transformers omitted in power-house substation.

LOW-TENSION DISTRIBUTING SYSTEM.

Entire length of track equipped with 60 lbs. conductor rail.

CAR EQUIPMENTS.

Each car equipped with two 150 H.-P., D.-C. railway motors and multiple control apparatus complete.

ESTIMATED FIRST COSTS OF ELECTRICAL EQUIPMENT.

POWER STATION.

Three 400 K.W., 25 cycle, 360 V., 3-ph., A.-C. gens., at $6,500 each	$19,500
Seven 150 K.W., 350 to 20,000 V., self-cooling, oil-insulated trans., 25 cycle, at $1,225	8,575
Switchboard	4,500
	$32,575

HIGH-TENSION LINE.

48 miles of 20,000 V., 3-ph. transmission line. No. 6 B. & S. gauge conductors are $900 per mile	$43,200
Lightning protection	2,500
	$45,700

SUBSTATIONS.

Twelve 135 K.W., 20,000 and 360 V., 25 cycle, oil-insulated, self-cooling transformers, at $1,175 each	$14,100
Five 400 K.W., 600 V., 25 cycle rotary converters, at $5,200 each.	26,000
5 switchboards, at $2,800 each	14,000
	$54,100

LOW-TENSION DISTRIBUTION SYSTEM.

63 miles of 60 lbs. conducting rail at $2,500 per mile installed	$157,500
Bonding main track—63 miles at $400 per mile	25,200
	$182,700

CAR EQUIPMENT.

12 D.-C. car equipments complete, consisting of 2 No. 50-C motors, with multiple control outfit, heaters and contact shoes, at $5,217 each	$62,604
Total first cost electrical equipment	$377,179

ESTIMATE OF YEARLY OPERATING EXPENSES.

D.-C. SYSTEM.

5 men at P.-H., 2 shifts, aver. wage $900 per yr	$9,000
1 man at each of 4 substations, 2 shifts, at $900 per year each	7,200
Fuel, water, oil, etc., at ½ ct. per K.W. hr—4,890,000 K.W. hr	24,450
Repairs and maintenance of P.-H. (3 per cent of cost per year)	971
Repairs and maintenance of H.-T. line (5 per cent of cost per year)	2,285
Repairs and maintenance of substations (4 per cent of cost per year)	2,064
Repairs and maintenance of 3d rail (1 per cent of cost per year)	1,822
Repairs and maintenance of car equipments (12 per cent of cost per year)	7,512
Total yearly operating expenses	$55,404

ALTERNATING-CURRENT RAILWAY SYSTEM.

POWER REQUIREMENTS.

Average real K.W. at car in typical 2-mile run (Fig. 2)	73.9	K.W.
No. cars running at one time	8	
No. substations	5	
Average No. cars per substation	1.6	
$\sqrt{\text{Mean}^2}$ apparent K. W. per car	129.0	
$\sqrt{\text{Mean}^2}$ amps. per car (3,000 volts)	43.0	
$\sqrt{\text{Mean}^2}$ amps. per substation $= m$	68.8	
With substations 12 miles apart, 80 lbs. track rail and No. 0000 trolley, resistance between substations allowing for increased rail resistance	4.2	ohms
Trolley and rail loss per substation $= \frac{r\,m^2}{6} =$	3.32	K.W.
Average real K.W. per substation at cars $= 73.9 \times 1.6 =$	118.0	
Average real K. W. per substation at substation	121.32	K.W.
Per cent loss in regulator and car transformer	5.0	per cent
Per cent loss in trolley and rails	2.8	per cent
Per cent loss in step-down transformers	3.5	per cent
Per cent loss in high tension line	2.5	per cent
Per cent loss in step-up transformers	3.5	per cent
Total per cent loss	18.4	per cent
Average real K.W. consumed by 8 cars at the cars	591	K.W.
Average real K.W. at power-house for 8 cars	700	K.W.
Average apparent K.W. at power-house, about	825	K.W.
Max. load per substation—worst condition, 2 cars starting (say, 275 apparent K.W. each)	550	K.W.
One 350 K.W. transformer will take care of this with fifty per cent overload.		
Average load on substation, about	40	per cent
These transformers are sufficiently large to take care of road if one is cut out.		
Max. load on P.-H. in apparent K.W., say	1,400	K.W.
Can be taken care of with three 450 K.W. generators—one for spare.		

STEP-UP TRANSFORMERS.

Three 400 K.W. transformers—load can be carried by two in case of emergency.

HIGH-TENSION LINE.

One No. 3 B. & S. gauge line each way from P.-H. 20,000 volt, 1-ph.		
Max. loss, about	8.2	per cent
Aver. loss, about	2.7	per cent

SUBSTATION EQUIPMENT.

4 substations. P.-H. feeds directly into 3,000 volt trolley.
Each substation to contain:
- One 350 K.W. transformer.
- Switchboard.

LOW-TENSION DISTRIBUTING SYSTEM.

Entire length equipped with No. 0000 B. & S. gauge trolley.

CAR EQUIPMENTS.

Each car equipped with two 165 H.-P., A.-C. railway motors with multiple control apparatus complete

ESTIMATED FIRST COSTS OF ELECTRICAL EQUIPMENT.

POWER STATION.

Three 450 K.W., 25 cycle, 3,000 V., 1-ph., 2,000 alt. gens., at $7,000 each	$21,000
Three 400 K.W., 17 cycle, 3,000 to 20,000 V., oil-insulated, self-cooling trans., at $2,500	7,500
Switchboard	3,800
	$32,300

HIGH-TENSION LINE.

48 miles of 20,000 V., 1-ph. transmission line. No. 3 B. & S. gauge conductors at $1,200 per mile	$57,600
Lightning protection	2,000
	$59,600

SUBSTATIONS.

Four 350 K.W., 2,000 alt., 2,000 to 3,000 V., oil-insulated, self-cooling transformers at $2,200 each	$8,800
5 switchboards, at $1,500 each	7,500
Auxiliary signaling lines for operating substation switches	7,500
	$23,800

LOW-TENSION DISTRIBUTION SYSTEM.

63 miles of No. 0000 trolley wire in place at $900 per mile	$56,700
Bonding main track—63 miles at $400 per mile	25,200
15 miles of pole line construction, not included in H. P. lines, at $630 per mile	9,400
	$71,300

CAR EQUIPMENT.

12 A.-C. car equipments complete, consisting of two 165 H.-P. motors, with multiple control outfit, heaters and trolley, at $8,482 each	$101,774
Total first cost electrical equipment	$308,774

ESTIMATE OF YEARLY OPERATING EXPENSES.

A.-C. SYSTEM.

5 men at P.-H., 2 shifts, aver. wage $900 per yr. each	$9,000
Fuel, water, oil, etc., at ½ ct. per K.W. hr	23,050
Repairs and maintenance of P.-H. (3 per cent of cost)	969
Repairs and maintenance of H.-T. line (5 per cent of cost per year)	2,980
Repairs, maintenance and inspection of substations (six per cent)	1,428
Repairs and maintenance of trolley (4 per cent per year)	3,652
Repairs and maintenance of car equipments (10 per cent)	10,177
Total yearly operating expenses	$51,256

is a question whether alternating current in the rails will interfere with telephones and similar instruments more than the direct current which they have to contend with at present. In any event, the amount of current in the rails can be reduced by the use of higher voltages so that this source of interference can be made less than it is with the present direct-current system. Further means have been proposed whereby the current can be confined entirely to separate conductors provided for the purpose and not allowed to wander at will through any return circuit that may exist, as is the case with the direct-current system. This can be done, of course, only at the expense of erecting a separate system for the return currents and a system of series transformers whereby these currents can be confined to this return system.

Comparison of Costs of Direct and Alternating-Current Systems—To determine by which of the two systems can a given service be rendered most economically, we shall assume a certain typical interurban road, ascertain the first cost of both systems and the cost of operating by both systems and compare the results. Suppose the typical road which we will assume to be as follows:

Length, sixty miles.

Schedule speed, thirty miles per hour.

Cars running half hour apart.

Number of stops, thirty—that is typical run, two miles long.

Weight of direct-current car, complete, thirty-five tons.

Weight of alternating-current car, complete, 41.3 tons.

It may be noted here that the above difference in weight of the cars is not the minimum that can be obtained. A large part of the difference in weight comes in the induction regulator, with which it is assumed the alternating-current car is equipped.

Fig. 1 shows the speed-time and kilowatt-hours curve of a direct-current car of thirty-five tons over the typical run. The equipment, gear, ratio, acceleration, etc., are given on the curve.

Fig. 2 shows the same for an alternating-current typical run and in addition gives also the apparent kilowatt and power-factor. It will be noted that the difference in power at the car is only ten per cent in favor of the direct-current equipment, in spite of the fact that the difference in weight is eighteen per cent in favor of the direct current.

The location of the power-house is assumed in both cases to be on the line of the road midway between the termini, therefore thirty miles from each terminus.

In each case, also, one of the substations is located in the power-house. In the alternating-current proposition the generators are wound for trolley voltage (3,000 volts) and feed directly into the trolley.

In each case, also, there are supposed to be four feeding points besides the power-house, thus making the substations twelve miles apart in both cases.

Further, in both cases the secondary is a single network, thus gaining the advantage of two feeding points except beyond the end substations. In neither system are secondary feeders figured on, the alternating current being simply a 4-0 trolley wire throughout, and the direct-current a sixty-pound conductor rail. In the direct-current system the high-tension line is supposed to be along the right of way of the road and the high-tension poles are utilized for supporting the trolley wire with a bracket construction.

Recognition of the fact that the alternating-current car is the heavier and requires more energy is made and larger motors than on the direct-current car estimated on.

In the direct-current proposition the generators, transmission line, etc., are supposed to be three-phase, naturally making necessary smaller transformers than in the single-phase system.

The parallel columns in the table give comparison of the power consumption, the losses in the various transmissions and transformations, the first cost of the apparatus used and an estimate of the operating expenses. The conditions are taken as nearly as possible to those in the typical road. Location will, of course, make differences in many of the items considered, but especial care has been used in estimating those items in which the two systems present a difference.

NOTES ON THE ABOVE COMPARISON.

First Cost—In the first cost of the two systems above compared no allowance is made for the fact that the alternating-current system requires less energy at the power-house and therefore will economize to a considerable extent in both engines and boilers. On account of the greater apparent kilowatt for the alternating-current system, generators and transformers will be larger in capacity, but the engines and boilers need not be so great in capacity. So far as transformers are concerned, the alternating-current system has the advantage because it allows the use of considerably larger units than the direct-current where three-phase transmission is necessary instead of single-phase, as is the case in alternating-current system. The alternating-current switchboards also have the advantage in that two switches per panel are required instead of three.

To render a given service over high-tension line, more copper is required for a single-phase line than for a three-phase line, and this makes the copper for the alternating-current system somewhat more expensive than for the direct-current system. The largest difference, however, in the high-tension line items comes from the fact that the poles for the high-tension line are spaced sufficiently close to allow the trolley brackets to be supported from the same poles. In the direct-current system, the spacing need be only sufficient for the requirements of the high-tension line alone.

So far as substation transformers are concerned, the alternating-current system has the advantage of single-phase over three-phase in that larger units are used. By far the largest item of saving in substation equipment between the two systems is of course in the omission of rotary converters in the alternating-current system.

The greatest difference in first cost of the two systems is of course the great difference in the cost of the secondary network. A glance at the comparative values will show that this difference in the case we have considered amounts to nearly $100,000, and is therefore nearly thirty per cent of the total cost of the direct-current system.

In first cost the alternating-current car equipments are of course considerably higher than the direct-current. I would call attention to the fact, however, that the costs of the alternating-current car equipment include an induction regulator. If some other style of regulator, such as, for instance, loops on the car transformers, has been figured upon, the cost of the alternating-current car equipments might be diminished by something like six per cent; that is, something over $6,000. The saving in weight by the same change and the consequent saving of power in the alternating-current system would amount to nearly four per cent of that which have been figured upon. In the item of maintenance of the control apparatus, however, it is believed that the induction regulator has the advantage in that it is not necessary to break the current in going from step to step.

The alternating-current system throughout is figured on the basis of using a fre-

quency of 2,000 alternations per minute. This frequency could be increased to, say, 3,000 alternations per minute at the expense of first, a considerably decreased power-factor and, consequently, increased apparent kilowatts; second, increased generator and transformer capacity; third, increased line and rail loss; and fourth, increased cost of motors. This difference might run the cost of the alternating-current car equipment some five per cent higher than figured on. It will be noted that the great saving comes in changing from direct current to alternating current, and that a change in frequency within moderate limits affects a change by no means comparable with that which is affected by going to alternating current.

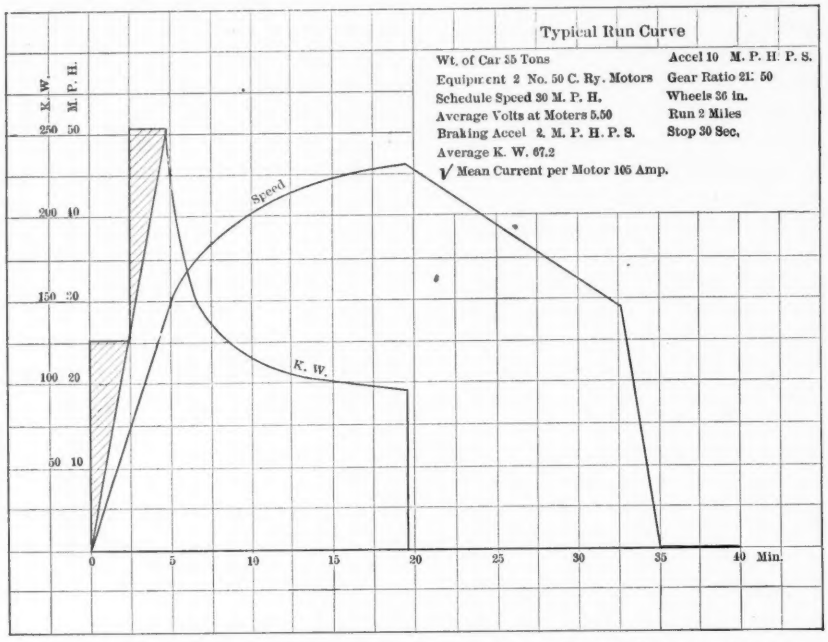

Typical Run Curve
Wt. of Car 35 Tons
Equipment 2 No. 50 C. Ry. Motors
Schedule Speed 30 M. P. H.
Average Volts at Moters 550
Braking Accel 2. M. P. H. P. S.
Average K. W. 67.2
√ Mean Current per Motor 105 Amp.
Accel 10 M. P. H. P. S.
Gear Ratio 21: 50
Wheels 36 in.
Run 2 Miles
Stop 30 Sec.
K. W.
M. P. H.
Speed
K. W.
250 50
200 40
150 30
100 20
50 10
0 5 10 15 20 25 30 35 40 Min.

FIG. 1.—SPEED TIME AND KILOWATT-HOUR CURVES OF A DIRECT-CURRENT CAR OF THIRTY-FIVE TONS, OVER THE TYPICAL RUN.

Operating Expenses—In the labor item it will be noted that the main saving comes in that substation attendance is avoided by the use of the alternating-current system. In other respects the labor items will be the same.

The fuel item for the alternating-current system is somewhat smaller than for the direct-current system, as the actual energy at the power-house is less in the former case than in the latter.

Besides labor and power, the main operating expense for any interurban railway system comes in the items of repairs and maintenance. It will be noted that this item of repairs and maintenance has been included in the above comparison by assuming that it is a certain percentage of the first cost in each case. There may be some difference of opinion as to the percentage that should be assumed in the various cases of this item of repairs and maintenance, but I have endeavored to make the comparison between the two systems as fair as possible. It is not intended to include any item of depreciation in these repairs and maintenance figures. It will be noted that a marked difference is made between the maintenance of a third rail and trolley by allowing one per cent in the one case and four per cent in the other. The apparent discrepancy in allowing five per cent for the maintenance and repairs on the high-tension line and only four per cent for that of the trolley is explained by the fact that the five per cent on the high-tension line includes the repairs and maintenance and the supporting structure for the trolleys.

The matter of inspection of the alternating-current substations is taken care of by allowing six per cent in the case of the alternating-current substations instead of four per cent as in the direct-current substations.

In the matter of repairs and maintenance of the car equipments, it will be noted that twelve per cent is allowed in the direct-current system and only ten per cent in the alternating-current system. Even this difference in percentage allows $10,000 per year for the maintenance of the alternating-current equipments in the place of $7,500 for the direct-current, or twenty-five per cent more for the alternating current than for the direct current. The alternating-current motors being lower in voltage and being protected from direct lightning discharges by the intervention of a transformer ought to have at least a no higher maintenance bill than the direct-current motors. The number of motors in each case is the same. The alternating-current system, however, will require a certain amount of attention for the transformers and regulators. This item, though necessarily not based on experience, is estimated to represent the comparative conditions as closely as is possible at this time.

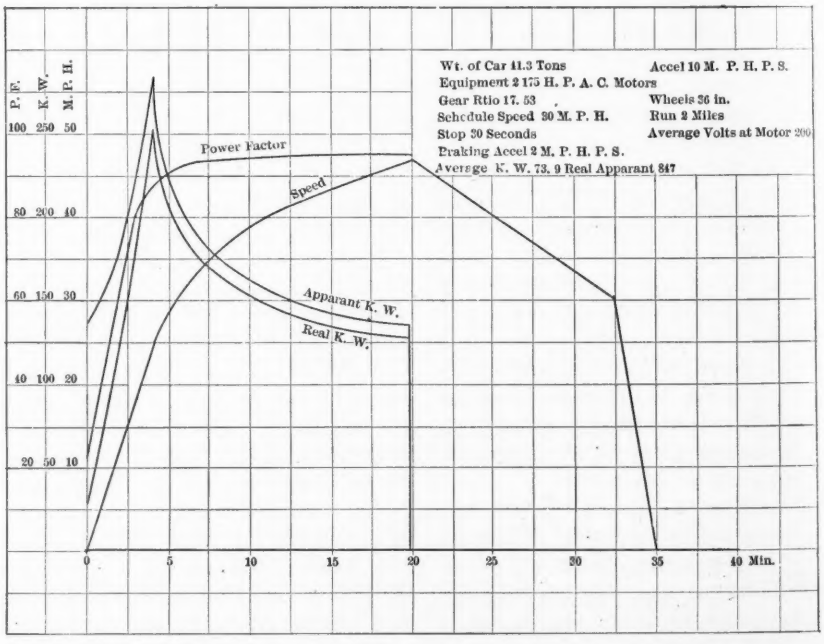

Wt. of Car 41.3 Tons
Equipment 2 175 H. P. A. C. Motors
Gear Rtio 17. 53
Schedule Speed 30 M. P. H.
Stop 30 Seconds
Braking Accel 2 M. P. H. P. S.
Average K. W. 73. 9 Real Apparant 847
Accel 10 M. P. H. P. S.
Wheels 36 in.
Run 2 Miles
Average Volts at Motor 260
P. F.
K. W.
M. P. H.
Power Factor
Speed
Apparant K. W.
Real K. W.
100 250 50
80 200 40
60 150 30
40 100 20
20 50 10
0 5 10 15 20 25 30 35 40 Min.

FIG. 2.—SPEED TIME AND KILOWATT-HOURS CURVE OF AN ALTERNATING-CURRENT CAR OF FORTY-THREE TONS, OVER THE TYPICAL RUN.

A Demonstration of the Cooper Hewitt Mercurial Vapor Lamp at the Technology Club, New York City.

The Technology Club, of New York city, at its meeting on the evening of Thursday, December 10, had the great privilege of listening to an address by Mr. Peter Cooper Hewitt on the production of his mercurial vapor lamp, and witnessing a demonstration of this apparatus by Mr. Percy H. Thomas.

Mr. Calvin W. Rice introduced Mr. Hewitt, paying a tribute to the work he has done, and dwelling on the good fortune of the Technology Club in having before it so prominent a speaker.

Mr. Hewitt described briefly the technical features of the lamp, and told of some of the difficulties which had been overcome in bringing the lamp up to the condition in which it exists to-day. He caused considerable amusement by stating that the lamp has a serious disadvantage, in that all who had the fortune or misfortune of being under its rays had every appearance of being those who "had been."

The operation of the lamp depended upon three important functions: the resistance, respectively, of the positive and negative electrodes, and of the mercury vapor column. It was found in the early experiments that a careful adjustment of the radiating area made considerable differences in the illuminating intensity of the mercury vapor column. Everything in the lamp had to be worked out in certain proportions, as it was found that the current used varied with the cross-section of the electrodes and directly with the length of the vapor column. One of the most important features of this lamp, and one which gave probably the greatest amount of trouble, was the very great resistance at the negative electrode. This resistance has the ability of forming very rapidly, and is sometimes of such a nature that a pretty large sized piece of platinum used as an electrode would be fused and kept in a molten state by the increased resistance. Another property which gave great trouble was the electrostatic charge which gathered on the outside of the glass, this sometimes piercing the glass through a bubble and causing a leak in the tube. This difficulty had been overcome by the use of what Mr. Hewitt calls his starting band.

The lamp is now made in two forms. One form of lamp is suspended in a practically horizontal direction, a mercury electrode being used at one end, and an iron electrode at the other. The arc is started by the use of an induction which gives a high-potential kick, after which the current at low voltage is maintained across the conducting vapor. The other form, or tilting method, employs a shunt resistance with the lamp, and in this case the lamp is tilted until the mercury runs from the positive electrode to the negative; and after it is tilted back, the arc persists until the mercury has flowed back to the positive electrode. The current then takes the vapor path, the vapor at the same time becoming brilliantly incandescent. It is noticed that at first the light has a good deal of green in it, but as the tubes warm up and the condensation on the inside of the tube flows back to the mercury chamber, the light becomes nearer to a white, and more intense.

Mr. Hewitt felt confident in the great commercial utility of this lamp. Already it was enthusiastically received by commercial photographers and was having a wide adaptation in photo-engraving processes. In many places, such as drafting rooms and factories, the lamp was superior to any other form of illumination, in that its intensity was constant and it possessed absolutely no single bright point, eliminating entirely all sharp shadows. It was not only as a method of producing illumination that the lamp had its utility. Its development had brought to the notice of the inventor other phenomena which would have great practical uses in the art. The same phenomena which obtained in the mercurial vapor lamp were being made use of in the mercury vapor converter, the discharge-gap or interrupter, and the circuit-breaker or switch. In each of these apparatus the high negative electrode resistance was made use of in a most stable and perfect manner.

Again, Mr. Hewitt thought that the lamp would probably become very useful in employing other vapors. With each gas there was a very active chemical work, but with many forms of vapor which had been experimented with there was a disintegration of the leading-in wires, or even the glass. He said that mixed vapors appeared to have a very much higher resistance than the mercury vapor column.

Following Mr. Hewitt, Mr. Percy H. Thomas gave a demonstration of the work of the lamp, starting several lamps by the high-potential kick, and also by the tilting method. He exhibited the various forms of the lamp, stating that the normal lamp is too long for use in some installations, as at present constructed. In order to satisfy a certain demand, a standard form of lamp had been made, two of which were used in series on 110 volts. The normal lamp took about three or four amperes at 110 volts. Mr. Hewitt, he said, had not only produced a practical lamp, but had also done a great deal in clearing up a number of questions of the properties of gases in a high vacuum, through which an electric current was being passed. He presented several interesting analogies as to the functions of the lamp, and stated that the salient features were the great quantity of illumination, the extreme economy, the effective distribution of light, and the great actinic power for photographic purposes. The lamp could be made to give a better color by the use of screens treated with fluorescent dyes, and he stated that these screens were now being used in several studios, interposed between the object and the lamp.

He then described the action of the mercury vapor interrupter and of the alternating-current rectifier. Both of these had been described at length in the technical press, and were well known. The alternating circuit-breaker, however, had not been given, Mr. Thomas thought, the attention which it deserved. It was remarkable that this apparatus, hardly larger than a man's fist, could quietly open a circuit handling, say 14,000 kilowatts, and which, with a mechanical switch, it was necessary to have an elaborate oil-break apparatus. This mercury vapor switch is a simple adaptation of the negative electrode resistance which obtains in each of the three pieces of apparatus. The application of the apparatus to the breaking of alternating current is quite simple. Suppose an alternating current is passed through the lamp. With the negative electrode resistance the current goes out at the end of the first alternation. If, however, by some means the current to be interrupted is made to pass through the lamp, it simply means that a mechanical circuit be established, which will be kept intact as long as the mechanical circuit is not disturbed. The switch is so constructed that when the globe is tipped in one direction, it connects the mercury in the electrodes, establishing a mechanical circuit. When it is tipped in another direction the arc persists across the vapor until the current arrives at the zero point. The negative electrode resistance then prevents the return of the alternating wave, and the current can not reform. In this way the current dies out quietly without any exhibition of the pressure phenomena usual with a switch handling high-potential currents.

Following the address by Mr. Thomas, there was a short discussion, in which he answered several questions which were raised.

A vote of thanks was tendered to Mr. Hewitt and Mr. Thomas for the address and demonstration, after which the meeting adjourned.

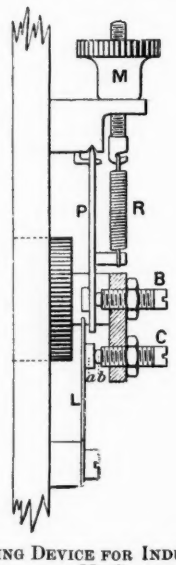
Electrical Notes from Europe.

By Our Special Correspondent.

PARIS is soon to have an electric plant which will be one of the largest in Europe. The new station will be erected by the Société Energie Electrique, a large company which has been recently founded for distributing light and power in the city and suburbs. It is also expected to supply some of the new substations of the Metropolitan underground. The plant will be located on the banks of the Seine in the suburb of St. Denis, where it will easily secure a supply of water and coal. Machines to the extent of 60,000 horse-power will be installed in the new station, and one of the interesting features will be the use of steam turbines to give the motive power. These turbines are of the Brown-Boveri-Parsons type, which have been already used with considerable success in Switzerland and elsewhere. The turbines for the Paris station are to have an unusually high power. Each of the direct-coupled units is expected to give 10,000 horse-power at the maximum. These turbines, as well as the dynamos, are to be built in France by the Compagnie Electro-Mecanique, who hold the license for the system here. The first part of the station outfit will include four of the large turbine and dynamo sets, giving a total of 40,000 horse-power on a maximum load, or 30,000 for an average. Alternating-current machines will be used, and the fields will be excited by a direct-coupled turbine group of 350 horse-power. Part of the exciting current will also be furnished by a rotary converter. It is expected to use a large battery of accumulators in parallel on the exciting circuit.

A new form of X-ray apparatus has been invented by Dr. Oudin, a prominent specialist of Paris. Its principal feature is the powerful effect which he produces by concentrating the rays. The essential part of the apparatus is an improved Crookes tube which allows of applying the X-rays to the treatment of cancer situated in the interior of the body. The rays are collected and greatly concentrated by means of a tube having the shape of the finger, with a protected extremity. The new form of tube is said to give a radiating power which is fifty times that of the ordinary tube. At the same time, special precautions have been taken to protect the tube so that in case it should break the patient will not suffer from the action of the spark which might be thus produced.

The new telephone station which is being erected at Moscow will be one of the most complete in Russia. The building has five stories with a large basement. The main telephone room is situated in the fifth story. It contains switchboard accommodations for 22,500 subscribers. The fourth story is laid out for accumulators and dynamos, while the third story is taken up with the cloak-rooms for the employés. The second floor contains dining rooms, library, reading rooms, etc. The offices are situated in the second and first floors, while the basement serves for the storehouses, workshops and boiler rooms. The building is steam heated throughout. The construction of the new telephone exchange cost more than $100,000. Upon the opening of the new station, all the telephones of the subscribers will be replaced by a new apparatus of special design. In the new telephones, simply lifting up the receiver serves to call up the central station. At the same time a red light appears on the switchboard, produced by a small incandescent lamp. On the appearance of the signal light the employé connects with the subscriber without using a call bell, and after asking the name he wishes to have, the employé makes the proper connection. When he is through talking, the subscriber puts his receiver back in place, and this causes the red light to be changed to white light by means of another lamp beside the first. By this new system the method of making connections is greatly simplified.



NEW VIBRATING DEVICE FOR INDUCTION COILS, DESIGNED BY M. CARPENTIER.

It is reported from Germany that a severe storm which took place recently caused great damage to the telegraph and telephone lines in different parts of the country. Several days were needed to replace the broken wires and establish the direct communication with Holland, Belgium, France, Italy and Switzerland.

M. Carpentier, the well-known electric constructor of Paris, has lately brought out a new vibrating device for induction coils. In a make-and-break device of this kind it is recognized that the break should be made as quickly as possible, hence the adoption of different outside mechanical devices for accomplishing this. It was found that with an armature which is attracted by the core of the induction coil itself, the break occurs at the beginning of the stroke and consequently at the point where the armature is moving the slowest. This is the contrary of what should happen. When the break is made to occur at a point where the armature is moving rapidly, a quick break is secured which gives a much better effect in the coil, and this is noticed in the better quality of the spark. In the diagram, the armature P vibrates in front of the core, and is drawn back by the spring R; it rests normally against the screw B. The electrical contact for the coil is made between the platinum piece *a* carried on the spring L, and the platinum end *b* of the screw C. The core attracts P and when it is moving rapidly it strikes against the end of L, thus breaking contact between *a* and *b*. The break at *a b* is thus much more rapid than in the ordinary case, and gives a better spark in the coil. This device is now used very successfully on different forms of induction coil.

Telephoning to the shores of the Arctic ocean has now been made possible, according to the Swedish journals, by the extension of a line running from Stockholm to the north. The small village of Narosk, which forms the terminal point of the most northern line of railroad in the world, has been connected recently with Stockholm. The length of the new line which extends to the Arctic ocean is about 600 miles.

A series of experiments has been carried on in Germany by H. Ebert and P. Ewers,

which seems to prove that the air coming from the lower strata of the earth contains an emanation which is similar in effect to the emanation given off by radium. One of the principal phenomena produced by the emanation is the discharge of a pair of electrified plates which are exposed to its action. In the present experiments an iron tube having 1.2 centimetres bore was sunk in the ground to a depth of 140 centimetres. The upper end of the tube which projected from the surface was connected to a gasometer, so that the air could be drawn up through the tube and the gasometer filled with it. From the latter the air was passed into a bell-glass where the tests were made. Under the bell-jar was placed an Elster-Geitel indicating apparatus, consisting of a pair of plates whose loss of charge could be measured by an instrument placed on the outside. When the air coming from the ground was passed in the bell-glass, the conductivity between the plates was found to be increased in a large proportion, no less than twenty-two to one. This condition holds good for several days. It is supposed that the effect is due to the ionizing action of the air. No action is produced in similar circumstances by water vapor or carbon dioxide. The air coming from the ground is found to have an induced radioactivity, and this property diminishes less rapidly than in other cases. Gases and water vapor were removed from the air to prove that they did not cause the phenomenon. In such case the air still keeps its ionizing action, showing that it is not due to the presence of electrons, but to an emanation which transforms the neutral molecules of a gas in repose to electrified particles. When ordinary air is substituted in the bell-jar, the effect disappears.

Accumulators have been used with great success on the new submarine boat which the Russian Navy has built at the docks of the Baltic Company. The submarine, which made a cruise not long ago in the Gulf of Finland, with Captain Beklemischeff in charge, measures eighty feet long and has a displacement of 100 tons. It is found that the submarine can remain under water for five consecutive days, while traveling at a speed of eight or nine miles an hour. The equipage is composed of twelve men. The accumulators and motors were found to work very satisfactorily on these trials. When running at the surface of the water, the boat can reach a speed of twelve miles an hour.

The electric railway which is to pass through the Pyrenees region will form another connecting link between the French and Spanish railroad systems, and shorten up the distance from Paris to Madrid. A decision has been lately taken by the two governments as to the construction of a line of standard gauge electric road. The proposed line is to run between Ax-les-Thermes in France and Puycerda on the other side of the frontier, connecting at this point with the Spanish railway system. Another electric railroad to be installed in the Pyrenees region before long is the extension of the line of standard gauge road which now ends at Olette. From the latter point a new section of road is to be run as far as Puy. This part of the country, which possesses extensive mines and forests, will thus be opened up to the industries. Owing to the lack of transportation facilities it could not be easily reached. It is expected to complete these two electric railway lines within the next five years, as the work of drawing up the plans is now being carried on under the supervision of both governments.

One of the German plants which now uses electrically operated mine pumps is that of the Helios mines, in Gneisenau. The dynamo plant is located at the surface and the main cable passes down the mine shaft to an underground chamber which has been fitted up for the motors and pumping outfit. The station above ground contains two three-phase alternators of 7,000 kilowatts each, driven by steam engines. These alternators work at eighty-three revolutions per minute and deliver three-phase current at 2,600 volts. The machines are excited on starting by an independent exciter group formed of a generator direct-coupled to a steam engine. When the alternator comes up to full load, the fields are supplied by a motor-generator set. The pump room is located at a depth of 1,200 feet in the mine. Two cables take the current down to the motors. At present one motor is installed, having a capacity of 670 horse-power. It operates the pumps at sixty revolutions per minute.

At the International Exposition of Alcohol, which is to be held at Vienna next spring, will be seen different types of motor and dynamo groups in which the motors use alcohol as fuel. The exposition is to be held from April 16 to May 31. It is intended to bring out the recent progress of the production and methods of utilizing alcohol, and among the most interesting features will be the display of motors in which alcohol is used to form the explosive mixture. Such motors have been very successful in Europe for several years past, and many of the alcohol motors are used in direct-coupled dynamo sets, thus forming a compact and portable group which has many uses. Among other exhibits will be the new alcohol lamp, which uses an alcohol flame in connection with the Welsbach burner. This form of lamp is economical and gives an intense light. It will no doubt prove to be one of the competitors of electric light in the near future. The promotors of the exposition are taking measures to have apparatus introduced for the show free of duty. C. L. DURAND.

Paris, December 5.

The Operation of a Commutator in Oil.

In a recent issue of the *Zeitschrift für Electrotechnik,* Herr Osnos suggests the construction of a commutator to operate in oil. The form of the commutator should be that of a cylinder containing the oil, with the brushes rubbing on the interior. The presence of the oil gives, according to the author, the following advantages: the commutator operates well without causing short-circuits of the sections due to the brush spanning two segments, and for this purpose the armature has two distinct windings connected to alternate segments of the commutator. The oil prevents sparking, even when the voltage between adjacent segments of the commutator attains a value which, without the use of oil, could not be allowed. It will thus be feasible to construct commutators with few segments, while the coils on the armature may contain many turns. Oil also allows metallic brushes to be used, and this will decrease the surface contact which would be required by carbon brushes. At the same time, oil reduces friction and contact resistance losses. A commutator thus constructed may be so small that a series armature winding can be used, so that but two brushes will be necessary. The author lays stress upon the advantage which this arrangement will possess in the construction of alternating-current motors, and he believes that it will make possible the use of high voltages directly upon the windings, and do away with the necessity for transformers.

British Institution of Electrical Engineers.

The inaugural address of President Robert Kaye Gray, delivered at the opening meeting of the British Institution of Electrical Engineers, dealt fully with matters of local importance and gave a review of the year's progress. The following are some of the interesting points discussed:

Many opinions have been advanced as to the scope and aim of an Institution such as ours; as to what it should do and what it should not do, and as to its relations with kindred societies. In early days the institution was the only association or body which could voice the views of electrical men, and therefore everything touching their interests was fit matter for discussion. To-day the necessity is not so imperative, as, owing to the great development of the electrical industry, other bodies are springing up who can more properly deal with a variety of questions which affect, but only indirectly affect the Institution as an institution of electrical engineers. As time goes on this necessity will become less and less, and the Institution will fall back into its proper function as an institution of electrical engineers, and will not fill the part of an association of electrical engineers, which it has often been obliged to do in the past. The word "institution" in this connection bears in my mind the meaning of a body for dealing with technical interests, while "association" implies a corporation whose functions are related to everything affecting general interests.

It is interesting in this investigation to note that modern tendencies in England are decidedly in favor of the direct-current system with a three-wire distribution. The number of direct-current undertakings increased from 139 in 1901 to 214 in 1902 and 260 in 1903. For these three years the alternating-current stations numbered sixty-seven, sixty-eight, and sixty-nine respectively. There are now established in Great Britain thirteen two-phase and five three-phase stations, exclusive of power transmission stations. In twenty-nine cases supply is given on two or even more systems. Many of the alternating-current stations have taken up the supply of direct current, others have added two-phase or three-phase supply to their single-phase service, or have changed over completely to one of these. The direct-current system appears to be in no immediate danger of supersession, in part owing to the raising of the voltage, and the consequent possible extension of the service area. The number of voltages in use is somewhat confusing, and presents to the standards committee a difficult problem to solve. These voltages now amount to about sixteen, and out of 289 samples of pressures nearly one-third are declared at 230, more than one-sixth are given as 220, while voltages of 240, 200 and 100 claim about one-eighth each. There are between fifty and sixty stations which revel in more than one declared pressure. The extent to which the change from one voltage to another has taken place may be judged from the fact that in 234 cases the pressure is upward of 200 volts; sixty-four supply current both above and below 200, and there are only twenty-nine whose supply is entirely under 200 volts.

Among the remarkable things of the year may be mentioned as in course of construction four turbo-generators of the Parsons type, each rated at 5,500 kilowatts to 8,280 kilowatts, and occupying a space measuring only fifty-one and three-quarters feet by fourteen feet by twelve feet. A 6,500-kilowatt turbo-generating set is being built by Brown, Boveri & Company, which measures fifty-nine feet by ten feet by ten feet. A Curtis turbine of 5,000 kilowatts is running in Chicago; this turbine is a combination of the Parsons and De Laval systems, and is arranged with a vertical shaft, a somewhat inadvisable design. In shape it is cylindrical, and, including turbine and generator, stands twenty-five feet high, with a diameter of fourteen feet. It may be interesting to note that there are over half a million horse-power of turbines in use or on order, and twenty-four stations in England use the turbine more or less. While referring to large units, it may be of value to state that the Société Cockerill, of Seraing, is expected to show at the St. Louis exhibition next year a gas engine of 3,000 horse-power; this engine will have two cylinders, each of fifty-one inches diameter, and will run at eighty-five revolutions per minute. It is said that the Gasmotoren Fabrik Deutz is designing a 6,000-horse-power engine.

Since the establishing of the Portrush electric tramway in 1883 the electrical engineer has encroached on the field of the tramway engineer, and consequently the purely tramway work, as apart from the electrical work, has often shown the mark of the active, clever, but untrained mind, impossible curves and grades being attempted, and unnecessarily expensive work being done. There has been some advantage in this no doubt, as the experience gained by these works, although expensive, has tended to improvements in practice. There is an American manner in this mode of procedure which leads to a free use of the scrap heap. We have been toiling up a steep hill for many years, and the time has now arrived when we should stop and survey the landscape as a whole, instead of narrowing our views to the particular point toward which we happen at the moment to be ascending. Already many of the paymasters are questioning the scrap-heap theory, as they know by experience that this is often evolved from nothing but a craving for change and a want of appreciation of the true value of money on the part of their advisers.

The application of electric traction to our railways is progressing. At present the sections which are being dealt with are those which have a great traffic density or a frequent service. This policy is doubtless a wise one, as the railway companies limit the application of a considerable capital expenditure to the best paying division of their lines, and to those portions where the benefits to be derived are the most apparent. During the current year the first section of the Metropolitan District Railway conversion has been made, and it is expected before March of next year that the Moorgate street, Drayton Park and Drayton Park-Finsbury Park sections of the Great Northern & City Railway Company will be in operation. The Mersey Tunnel Railway has been completed, and the conversion of the Wirral Railway is under consideration. The North-Eastern Railway has had trial runs along Tyneside, and good progress is being made with the Liverpool-Southport line. The Central London Railway is completing the change from locomotive to motorcar driving. The motorcar system is generally accepted as the best form for passenger traffic for many reasons which I need not recapitulate. The direct-current system at 500 to 700 volts appears to remain as a standard for railway work of this class, as well as for tramway work, but there are signs that single-phase alternating current may prove a rival. The three-wire system of feeding tramways and railways, though not without examples abroad, has not been adopted in England save on the City & South London Railway, where it seems to have proved satisfactory.

The advantages of electricity as a motive power seems to be readily appreciated. Among some of the large schemes in project is the electrification of the national railways of Sweden, the original power being derived from water pressure or the

combustion of peat. Estimates are being drawn for 2,700 miles of railway, calling for over 100,000 horse-power. The official estimate shows that there will result a saving of fifty per cent in the present working expenses, which amounts to about £800,000 per annum. Switzerland again speaks of a conversion of its national lines, entailing the use of 30,000 horse-power to be obtained from water pressure.

A year ago the gap in the world's telegraphic girdle was completed by the laying of the trans-Pacific cable which now unites Canada with Australia, and this year has seen completed a second line across the Pacific from San Francisco to the Philippines and China by way of the Sandwich Islands, Midway and Guam.

It is strange that during this development the improvements in the types of telegraph cable employed have not been great, nor has there been any great advance made in the design of the instruments used for the transmission of signals, but the administrative work has been vastly bettered. Messages which formerly took hours in transmission are now received from the public and delivered to the addresses in a few minutes. I am informed that a telegram announcing the result of the yacht race for the American Cup was carried, in August last, from London to South Australia in four minutes. This message, which was forwarded *via* South Africa, was handled by fifteen operators, passed through eleven stations, and traversed 14,404 nautical miles of submarine cable and 1,515 statute miles of land lines. Ordinary commercial traffic can not be dealt with at this speed, but the instance I quote shows what can be accomplished when special arrangements are made to carry news which is of peculiar interest. The manager of an American cable company has told me that the result of the American Cup Race reached London one minute after the termination of the race, having been transmitted through 3,400 nautical miles of submarine cable and some 200 statute miles of land wire. The record time between New York and London is thirty seconds, and messages have been sent and replies received in one minute and thirty seconds.

The use of the telephone continues to extend, and in addition to the greater facilities offered in Great Britain there are gradually being established international wires which place in telephonic communication the principal towns of Great Britain and several of the commercial centres on the Continent. So far as I am aware, no practical use has yet been made of Poulsen's telautograph.

In a quite different direction electricity is being used for the purification of the water supply of towns. There are two installations of this kind in Germany—Schierstein and Paderborn—where the Siemens ozonizing tubes are in use; air is charged with ozone by means of these, and is passed up dripping towers, down which the water trickles, with the result that it is completely sterilized as regards all deleterious organisms. At Schierstein the capacity of the plant is nearly 50,000 gallons per hour, and the power required is fifty horse-power, of which, however, only twenty-seven horse-power is used for ozonizing; the remainder serves for pumping, etc. The pressure used is 8,000 volts. The working cost is in all from threepence halfpenny to fourpence halfpenny per 1,000 gallons. By the Jaruti process water is electrolyzed to give pure hydrogen and oxygen, consuming 115 kilowatt-hours per 1,000 cubic feet. A solution of caustic soda is used, with a perforated iron diaphragm to separate the gases. At Stangfjorden, in Sweden, the Jebsen system is used for the manufacture of briquettes from peat. The latter is carbonized by heating with the electric current, derived from water power, and the tarry by-products are recovered. The production of nitric acid from the atmosphere has long been the subject of experimental research; it is now in active operation at Niagara Falls, where by means of electric discharges at extremely high pressures and frequencies the nitrogen and oxygen are caused to combine. The same subject has been dealt with on the Continent, where a return of fifty-two grammes to fifty-five grammes of nitric acid per kilowatt-hour has been obtained, using a current of 0.05 ampere at 50,000 volts and 6,000 to 10,000 cycles per second. As Sir William Crookes has shown, the fixation of atmospheric nitrogen may in the distant future have a most important bearing upon the existence of the vast population of the earth, when natural sources fail to furnish an adequate supply of food. In connection with this subject, the synthesis of sugars by the electrolysis of carbonic acid, ammonium, phosphate, etc., which has been accomplished by Walther, is of no little interest.

With wisdom, we in England open our arms to the skilled man of other countries, and through his skill we can, in certain directions, maintain supremacy in some of our productions. The pity of it is that we have not among our own countrymen men of equal education and skill. One may say that the electrical industry is also suffering, and that the signs of it are the large importation of American and German machinery into this country at the present time; but I venture to disagree. Americans and Germans are doubtless appearing on our markets, and in many cases owing to greater skill in manufacture; but the financial side of the question has a great deal to do with their incursion, and especially is this so with their competition in our colonies and in non-manufacturing countries. We must, as a policy, continue to welcome all comers, but while so doing we should equip ourselves so that by sheer skill and ability we may conquer in the end. The equipment we require is, everyone now admits, technical education, and thus we are developing in all directions. The electrical engineers as a class are better equipped than any other class I know of, thanks to the teaching received in our technical institutions from very capable men, some of whom we are proud to see numbered among the past-presidents of this Institution.

An Independent Telephone Directory.

The Inter-Ocean Telephone and Telegraph Company, 336 Ellicott square, Buffalo, N. Y., has issued the first edition of a combination directory of the independent telephone companies in the Buffalo-Rochester district in western New York. This directory contains all the names of subscribers to the local independent telephone exchanges which are connected directly with the Inter-Ocean Telephone and Telegraph Company's long-distance service. During the past two years there has been great activity in the central and western New York districts, in the development of independent telephone systems. It is a remarkable fact that there are now in operation in western New York 50,000 independent telephones, all of which are at present, or will soon be, connected with the Inter-Ocean company's lines.

This directory has been carefully prepared, and is an important addition to the business directories of the country. While the edition is limited, extra copies have been printed for distribution outside of the district covered by these exchanges, and the book can be secured by remitting fifty cents in stamps to the Inter-Ocean company, at Buffalo, N. Y.

General Electric Company.

It is stated that the General Electric Company anticipates fully as much business for 1904 as it has enjoyed during 1903. Recent arrangements made with large German interests, it is expected, will prove of importance in this connection.

Conductivity of Mercury Vapor.

By Peter Cooper Hewitt.

THE electrical conductivity of gases and vapors and its relation to the conditions under which the electrical current is maintained has occupied my attention for many years. A large number of experimental data accumulated during the progress of my work—when properly arranged and coordinated, furnish an explanation of electrical conduction through gases which seems to account satisfactorily for the phenomena observed. It was thought desirable to perform additional experiments for the purpose of obtaining exact quantitative measurements upon some particular gas and for this purpose mercury vapor was selected. The results of these experiments are given in the following brief summary. I was fortunate to secure during the progress of this work, the assistance of Dr. A. P. Wills, who expects to publish in the near future a detailed account of the methods and apparatus employed in this experimental study.

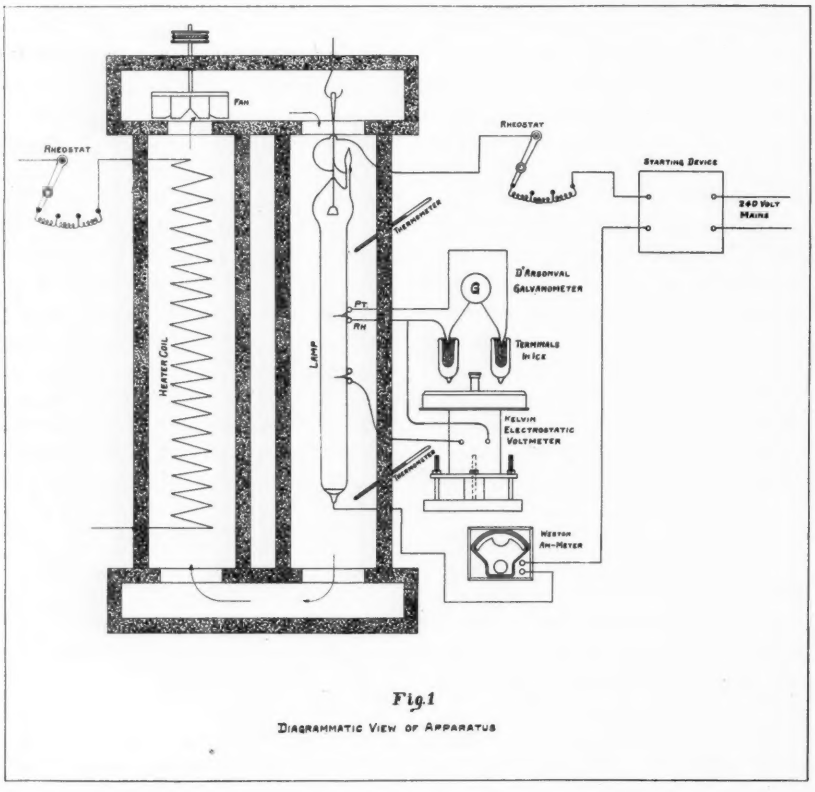


Fig. 1

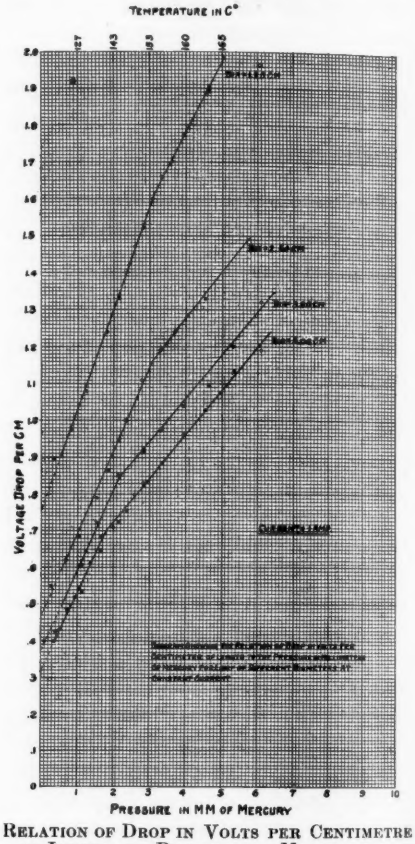
Diagrammatic View of Apparatus

Diagrammatic View of Apparatus for Studying Conductivity of Mercurial Fans.

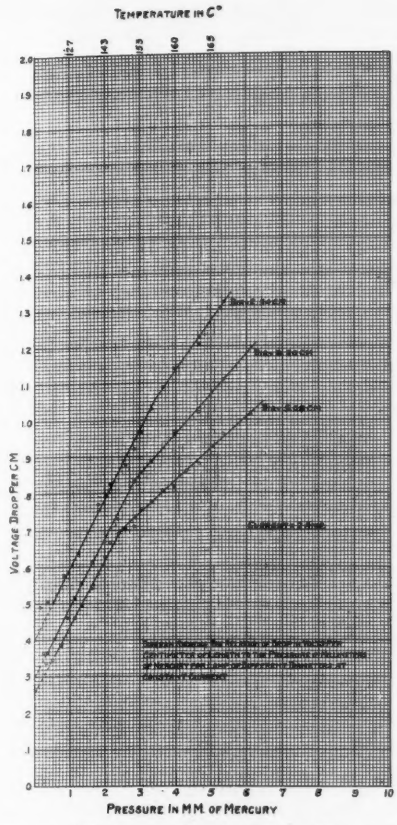
A gas or vapor forming part of an electrical circuit exhibits three distinct sources of electrical reactions, namely, one at the junction of the positive electrode of the conductor with the gas or vapor; one in the gas or vapor uninfluenced by the electrode effects; and one at the junction of the gas or vapor with the negative electrode.

Difficulty was experienced in obtaining electrical measurements upon the conducting gas or vapor independent of these electrode effects; the measuring instruments require the use of terminals or electrodes in contact with the gas or vapor with the electrode resistances accompanying them; difficulty was also met with in obtaining the gas or vapor in a state of purity. The results given in the diagrams are not vitiated by terminal or electrode effects. The measurements were taken in such a way as to be subject to but little variation from the effects of the current during the time of observation.

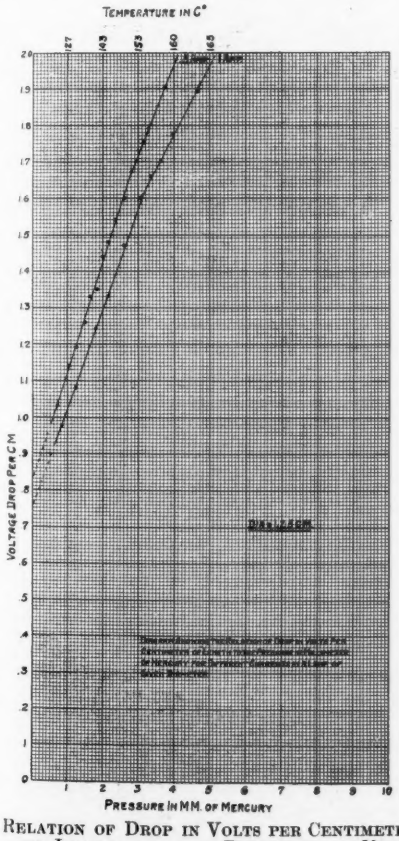
Fig. 1 is a diagrammatic view of the apparatus. Two upright chambers of insulating material were connected together at the top and bottom, thus forming one continuous air chamber. One chamber contained an electric heating coil, the current supply of which could be regulated externally; a centrifugal fan over this chamber produced a rapid circulation of the air contained by the two chambers for the purpose of bringing the whole to a uniform temperature which was regulated by the heating coil. In the other chamber was placed the vessel containing the gas or vapor, marked "lamp," with the necessary electric connections. Thermometers were inserted at both ends, as shown, for determining the external temperature. Two platinum-rhodium couples were sealed in the walls of the lamp at a measured distance apart, and extended to the centre. The external terminals of the couples were immersed in ice and connected to a D'Arsonval galvanometer. The internal temperature was measured by means of these couples by observing the deflection of the galvanometer. It was possible to ascertain accurately when the internal and the external temperatures were the same. The drop in volts between the platinum-rhodium points was taken by a Kelvin electrostatic voltmeter; the couples thus served a double purpose.



Relation of Drop in Volts per Centimetre of Length to Pressure in Millimetre of Mercury for Lamp of Different Diameters at Constant Current.



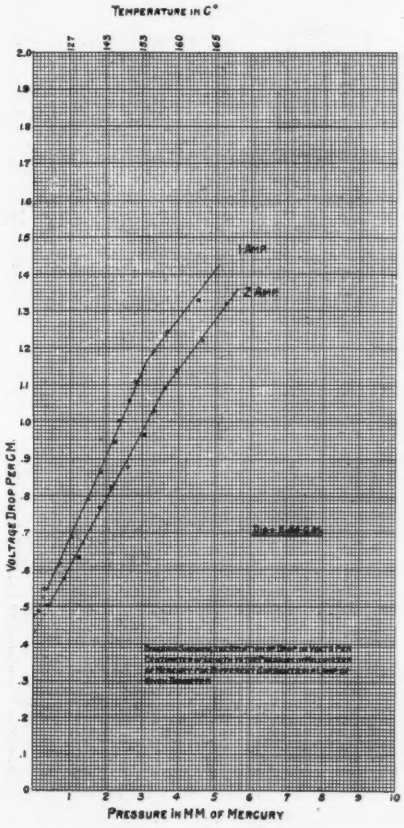
DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY.



RELATION OF DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY FOR DIFFERENT CURRENTS IN A LAMP OF GIVEN DIAMETER.

It was possible to obtain voltage measurements at the temperatures desired. When a required temperature was obtained internally and externally, the current was started through the lamp by the starting device, and was controlled by an external resistance and measured by a Weston ammeter. Immediately after starting the current, the reading of the Kelvin voltmeter was taken. There was sufficient time to obtain these readings accurately before the current materially altered the vapor density.

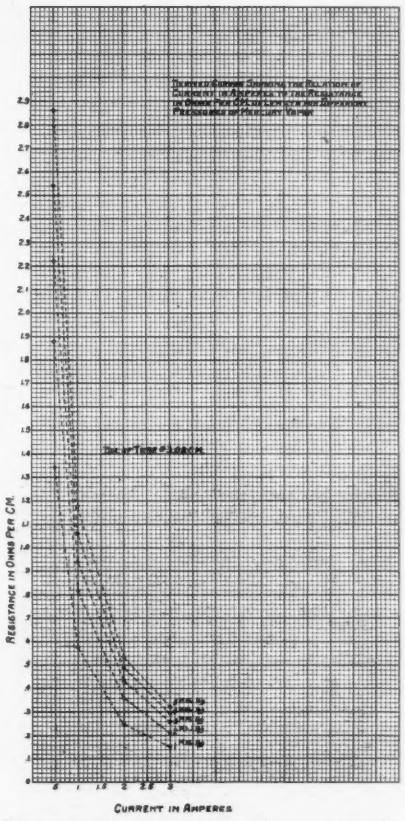
The lamps contained some mercury and were exhausted with great care until nothing but mercury and its vapor were present. The size of the tube used for the lamp limited the diameter of the conducting vapor column, and its diameter is the diameter given in the diagrams.



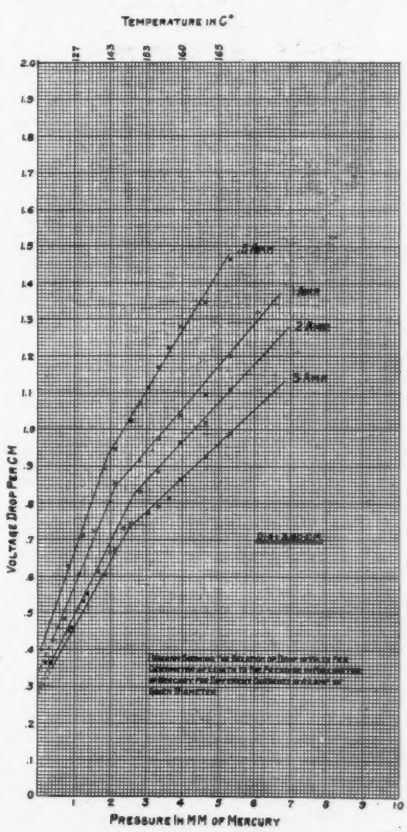
RELATION OF DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY FOR DIFFERENT CURRENTS IN A LAMP OF GIVEN DIAMETER.

The relation of the pressure of the saturated vapor to the temperature was deduced from the observations of Ramsay and Young; the density is proportional to the pressure. The walls of the lamp being covered by small globules of mercury and a large amount of mercury being present at the bottom of the lamp, the vapor was considered to be in a state of saturation.

The points on the curves indicate actual readings; the drop in volts and temperature were observed. In most cases the



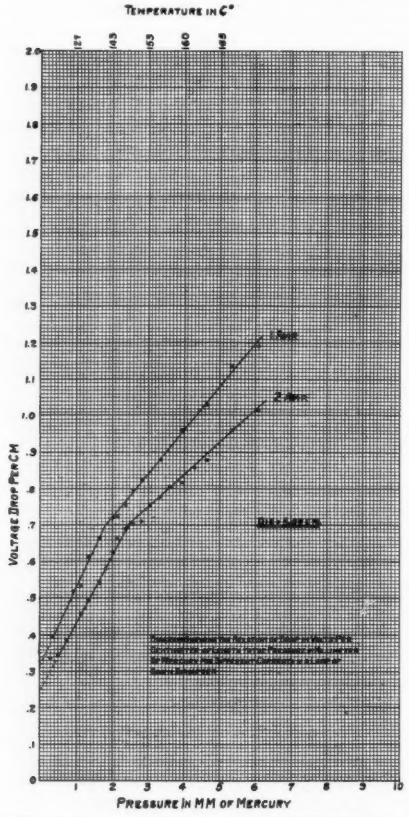
DERIVED CURVES SHOWING RELATION OF CURRENT IN AMPERES TO THE RESISTANCE IN OHMS PER CENTIMETRE OF LENGTH FOR DIFFERENT PRESSURES OF MERCURY VAPOR.



RELATION OF DROP IN VOLTS PER CENTIMETRE OF LENGTH TO THE PRESSURE IN MILLIMETRE OF MERCURY FOR DIFFERENT CURRENTS IN A LAMP OF GIVEN DIAMETER.

experiments were repeated many times with different lamps, and with the same lamp reexhausted in order to be certain that only mercury vapor was present in the lamp, since the presence of a small amount of another gas will cause considerable variation in the measurements. For instance, on admitting a different gas into a lamp containing a pure gas, the effect may be observed by the measuring instruments.

The diagrams show the influence of density, diameter and current on the drop in volts per unit length. From them can be deduced the resistance, as a function of the density, current and diameter. They show that the voltage required to maintain an electric current in a gas or

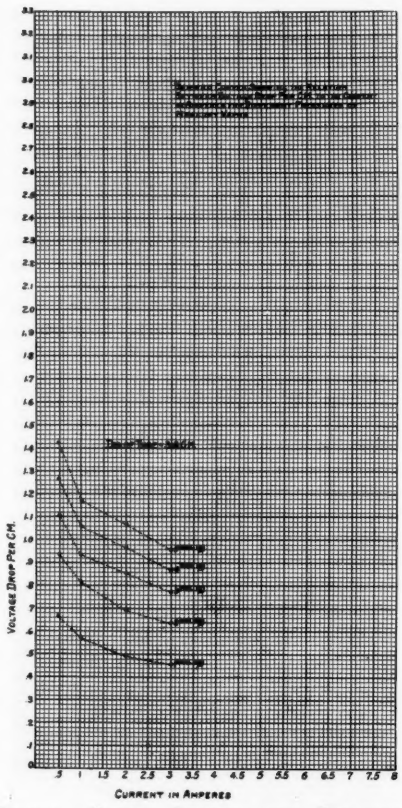


Relation in Volts per Centimetre of Length to the Pressure in Millimetre of Mercury for Different Currents in a Lamp of Given Diameter.

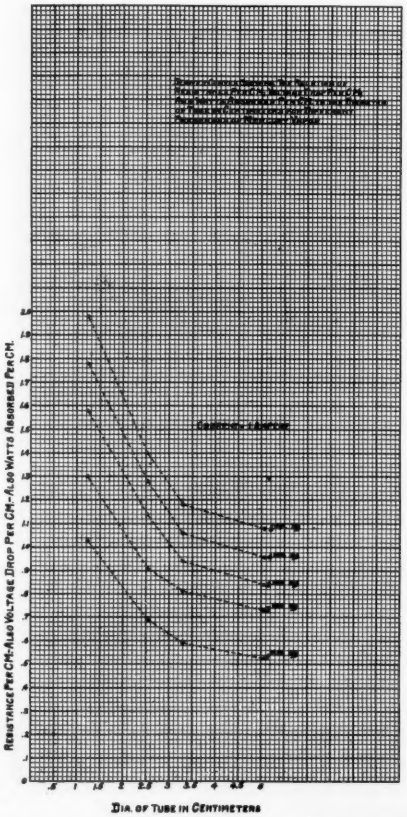
vapor is directly proportional to the density and that it decreases as the diameter of the lamp increases. The resistance decreases with increase of current. From the diagrams, relations among the diameter, density and current may be established.

The current assumes a definite cross-section for a given density and current when not restricted by the lamp; this cross-section increases with increase of current and decreases with increase of density. The angles in the curves shown may be due to these effects, but this point needs further investigation.

The light efficiency of mercury vapor varies with the density; there is a density of maximum light efficiency. On passing current at a very low density practically no light is visible and the drop in volts for the same current is less



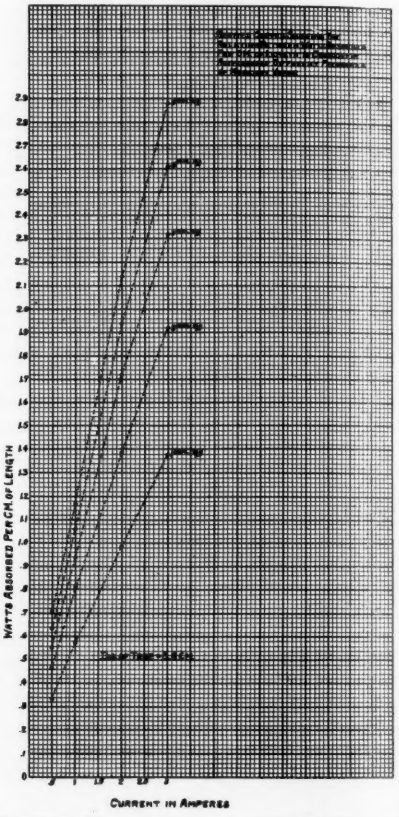
Derived Curves Showing the Relations between Voltage Drop per Centimetre to the Current in Amperes for Different Pressures of Mercury Vapor.



Derived Curves Showing Relation of Resistance per Centimetre, Voltage Drop per Centimetre, and Watts Absorbed per Centimetre.

than at greater densities. At greater than a certain limit the light efficiency decreases. If another gas is present with mercury vapor, the current is usually selective and gives the spectrum of mercury vapor, but the resistance is materially altered. The effect of magnetic force transversely applied at low densities is very marked, and is that of increasing the resistance in an extraordinary degree, while at higher densities it increases the resistance but little. Magnetic force alters the spectrum, particularly at low densities.

The experimental curves speak for themselves; the conclusions which may be drawn with respect to the relation of the conductivity of mercury vapor to the



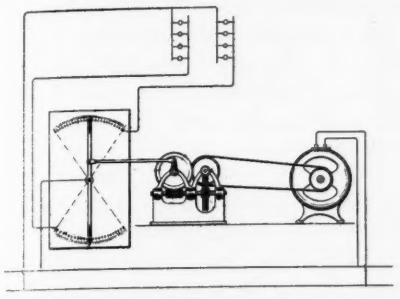
Derived Curves Showing the Relation between Watts Absorbed per Centimetre of Length to Current in Amperes for Different Pressures of Mercury Vapor.

physical conditions under which the electrical current through the vapor is maintained appear to be, broadly speaking, generally true for all gases and vapors. It is not necessary to enumerate here all these conclusions, for they are sufficiently evident on the face of the curves, but some derived curves are given which have been deduced from the curves obtained by direct experiment. They are marked in the diagrams as derived curves. There is one conclusion, however, which from a purely technical point of view deserves special attention. It is this:

When a given vessel containing mercury vapor is to be employed as a source of light, that is as an electric lamp, the highest light efficiency will be obtained when the vapor density and the current employed have a definite and fixed relation.

Electrical Patents.

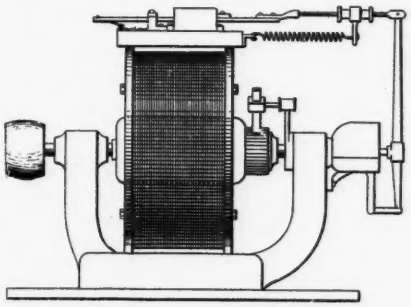
Means for operating electric signs is the subject matter of a patent granted to William Goltz, of Chicago, Ill. It is the object of Mr. Goltz in the present invention to employ means for operating the lamps without breaking the circuit, thus eliminating all injurious sparking. Another



DIAGRAMMATIC VIEW SHOWING ARRANGEMENT EMPLOYED FOR OPERATING ELECTRIC SIGNS.

feature is the provision of means whereby the lamps of an electric sign may be suddenly fully illuminated, and remain at full illumination long enough to be read and then suddenly darkened. A motive source, preferably a motor, connects by means of a belt with a train of reduction gearing, consisting of a pulley, carrying a belt, a worm, mounted on a common shaft with the pulley and engaging a worm-wheel, a second worm on a common shaft with the worm-wheel, and another worm-wheel engaged by said second worm, all mounted in suitable bearings. A crank mounted in common with the second worm-wheel transmits oscillatory motion to a contact lever on a dimmer by means of a connecting rod. The lever is pivoted at its centre, its ends being adapted to travel over resistance terminals. The connecting rod so engages the lever that as the crank revolves said lever will oscillate between the limits of resistance terminals. The high rate of revolution of the motor may thus be reduced to any desired rate of oscillation of the lever on the dimmer, controlling the illumination of the lamps on the sign. When the lever is at the ends of oscillation, the lamps are either dark or at full candle-power, and the connecting-rod-bearing centres and the crank-shaft centre will lie in the same plane. The crank end may move a considerable distance either side of this plane without causing enough motion of the lever ends to perceptibly affect the illumination. In fact, it may be said that the lever ends have harmonic motion. If it is desired to have full candle-power illumination continue a greater length of time, the corresponding end-resistance terminal may be lengthened to give prolonged or lingering contact.

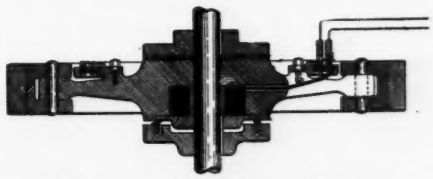
Mr. Alexander J. Churchward has obtained a patent on an alternating-current motor, the general object of which is to provide for the efficient operation and the ready control of such motors. The invention is designed especially for use with motors which have any usual direct-current armature winding and commutator and may be operated by feeding alternating currents to the commutator and field simultaneously, the field coils being preferably in series with the armature. The invention consists essentially, in the combination with the machine, of a transformer supplying alternating currents thereto and suitably wound to permit its voltage to be regulated through the medium of suitable switch devices that serve to throw in windings of the transformer to give an excess voltage at starting and afterward to throw out said windings and thereafter control the speed by preferably throwing out windings of the transformer and reducing the voltage supplied thereby when the speed rises above the normal or desired working speed and throwing in windings and increasing the voltage when the speed falls below such normal speed. The switch devices may be worked by hand or may be controlled by speed-responsive devices which act in accord with the speed of the armature. A suitable device for the purpose is a centrifugal



SHOWING A FORM OF MOTOR AND REGULATING MECHANISM.

governor. When a motor having a direct-current armature and commutator is operated by a single-phase current and run in synchronism with the alternating-current supply, the armature becomes in effect a constant field excited by the direct current flowing in the armature coils. The poles of the field magnet will act practically as a revolving field to rotate the armature. Operated under this condition there is no appreciable loss by hysteresis in the armature or by self-induction in its wires, and if this condition may be preserved the machine may be operated with high efficiency. The present invention permits this to be accomplished by varying the winding of the transformer which supplies the current to the machine, so as to increase the voltage if the speed falls below the synchronous speed and to decrease it if the speed rises above such speed.

Alexander Churchward, of New York, N. Y., has obtained a patent on an anti-hunting device, which he has assigned to the General Electric Company, of Schenectady, N. Y. The invention relates to certain improvements in anti-hunting devices for use in connection with synchronous motors, rotary converters, or in any other relation where such a device is desirable, and comprises various novel features. Mounted upon the shaft of the machine with which the anti-hunting device is to be used is a flywheel, which, against the opposition of a frictional resistance, is permitted to move relatively to the shaft. This frictional resistance, attendant upon relative motion between the shaft and flywheel, is the factor which damps out the hunting tendency of the shaft. To secure this frictional resistance to motion of the flywheel relatively to the shaft, the wheel is mounted so that its hub is yieldingly pressed between two friction discs. One of these discs, which may be of wood, fibre or the like, is held between the hub and a flange, keyed or otherwise secured to the shaft. The other disc is pressed against the hub of the flywheel by springs, placed between said disc and another flange, keyed or otherwise securely fixed to the shaft. This latter disc is splined upon the shaft, so as to be capable of a slight longitudinal movement thereon, but incapable of rotation about the shaft. Located within a recess in the hub of the flywheel is a magnetizing coil which is supplied with current from collector rings upon which bear brushes to which current is conveyed by means of leads. The friction between the flywheel and the parts between which it is yieldingly clamped is sufficient under ordinary conditions to prevent hunting of the machine to which the device is connected when the machine is running normally. When starting up the machine from a state of rest, however, this friction is insufficient to bring the flywheel up to speed as quickly as the driving machine comes up to speed. Under ordinary circumstances the flywheel requires a considerable time before it reaches a speed of rotation synchronous with the driving machine, during which interval the machine is apt to hunt or pump to a very inconvenient extent. By exciting the coil with current one of the discs, which is of magnetic material, is urged strongly against the hub of the flywheel by magnetic attraction and constitutes a stiffly yielding



SECTION OF ANTI-HUNTING DEVICE.

if not rigid connection between the flywheel and the shaft upon which it is mounted. The flywheel is thus brought up to speed as quickly as the shaft which drives it, thereby preventing the initial pumping of the driving machine. It will be evident that by adjusting the amount of current in the exciting solenoid the friction between the flywheel and the shaft may be adjusted accordingly, and this may be readily performed while the device is in normal operation in case adjustment for any reason is then desirable.

Reviews of Current Engineering and Scientific Literature.

Electric Lighting System of Fulda, Germany.

An interesting electric lighting station, operated by a windmill, is in service at Fulda, Germany, and is here briefly described by Herr F. Schneider. The windmill is of American make, twelve feet in diameter, and drives directly a four-pole dynamo at 300 revolutions per minute. The output of the dynamo is eighteen amperes at forty volts. It is used to charge a storage battery consisting of fifteen Polak cells. The voltage of the system is thirty. The lamps are connected directly to the circuit, and are twenty in number, all of them being osmium lamps. No automatic regulator controlling the dynamo is employed, the only instruments on the switchboard being a voltmeter and an ammeter; nor is there any method of regulating by hand the voltage of the system. The osmium lamps support very well such differences of voltage as are produced by the fifteen batteries between charge and discharge. The energy consumed by the lamps is not large. In spite of the irregular operation of the windmill, the plant works satisfactorily, requires little attention and was inexpensive.—*Translated and abstracted from the Revue l'Électricité (Berne), November* 15.

Swinburne's Electric Locomotive.

A method of driving electric locomotives, relating more particularly to the use of constant-speed motors, has been developed by Mr. James Swinburne, of Westminster, England. The rotor of the motor is mounted on the driving shaft which drives the driver wheels by means of coupling rods or other mechanism. The other element of the motor, which, under normal operation would be the stator, is mounted so as to be free to rotate in the opposite direction, and in rotating works an oil water pump of variable stroke. The liquid under pressure is led to a second set of pumps or engines which work on the axle of the driving wheel, and which also have a variable stroke. By varying the strokes of the pumps, the speed of the locomotive may be varied continuously from starting up to full speed, while the motor elements move at the same speed relatively to each other. At standstill the armature of the motor is stationary, the other element rotating at full speed backwards, while at full speed the latter is stationary with respect to the car. The stroke of the pumps is varied by means of eccentrics, which in one position give no throw; and the opposite, a throw double the combined eccentricity.—*Abstracted from the Mechanical Engineer (London), November* 28.

The Heating Effect of Radium Emanation.

When Rutherford and Barnes described their experiments, in which they attempted to determine the source of the energy which radiates heat from radium salts, Mr. Arthur Schuster disagreed with their conclusion, that the energy was set free during the several stages of disintegration of radium atoms. He thought that the effect should be attributed to the secondary radiation set up by the emanation, and he has made preliminary experiments to test his view. Air charged with a radium emanation was led through a tube containing a terminal junction formed by iron and nickel wires. The junction was left charged to a high negative potential during ten minutes; then taken out and placed side by side with an unexposed junction in a metal vessel kept at a constant temperature. The two junctions seemed at first to be at the same temperature, but the exposed one began to become warmer almost immediately, and after twenty minutes, was about one-tenth of a degree above the other. The test was repeated with the same result, and it was shown that there was no accidental disturbance which could have caused it. The author draws the conclusion that it is the third or last stage of disintegration of the radium atom at which the excited activity finally disappears or becomes negative, which sets the energy free.—*Abstracted from Nature (London), November* 19.

Single-Phase Traction Experiments.

The Union Elektricitäts Gesellschaft, of Berlin, has been experimenting with a single-phase traction motor, and is now operating two trolley lines with this apparatus. The motor was designed by Herren Winter and Eichberg. On one of the lines referred to above, which runs through the company's yards, the motor is supplied with single-phase current at forty cycles per second, 600 volts. The car is equipped with two forty-horsepower motors, and the controller is similar to that used for direct current. By short-circuiting the motors, they may be used as an electric brake. The other line runs between Johannistal and Sindlersfeld, and is a part of the Prussian State Railways which was placed at the disposal of the company for the experiments. The line is 4.1 kilometres long, single track. Since August 1 last the trolley car has been in regular service. It is equipped with two 125-horse-power motors. Current is supplied at 6,000 volts, twenty-five cycles. The motors are connected permanently in parallel. The high pressure is applied only to the stationary part of the motors and to the exciting apparatus. Elsewhere pressure does not exceed 190 volts. For lighting purposes the pressure is reduced by a transformer to thirty-five volts, and the incandescent lamps used show no flicker. The characteristic curves show that the efficiency of the motor is about eighty per cent. The tractive and speed curves are very similar to those for direct-current motors, and the power-factor varies with the excitation, and can be brought nearly to unity. —*Abstracted from the Electrical Review (London), November* 27.

The Training of Apprentices in an Engineering Works.

The efficiency of any industrial enterprise is dependent upon the degree of intelligent familiarity with the nature of the product and skill of manufacture which is possessed by those employed in the operations necessary to fabricate the finished output. The methods adopted for training its employés by the Westinghouse Electric and Manufacturing Company are described here by Mr. C. E. Downton, who has had much to do with organizing and developing the system. Two classes of apprentices are recognized —the ordinary apprentice and the engineering apprentice. The first course of work is provided for young men without technical education who desire to learn the machinist's trade, the object of the course being to train the men who take this course as skilled mechanics and inspectors and foremen. This class of apprentices does not progress through the works from one section to another, for it is not intended to give them a general knowledge, but, rather, a specific training in the manufacture of a definite line of work. Each section is practically a complete machine shop, and when the young man completes his course, he is able to handle any of the machine tools

there used. After three months of probation the apprentice is allowed to become indentured. The entire course lasts four years, and at its completion the graduate is given a gratuity of $100 and a diploma. The compensation varies according to the man's age and the time served, from five cents to fifteen cents per hour. The engineering apprenticeship provides for young men who are graduates of technical schools. This course lasts two years, sixteen cents per hour being paid for the first year, and eighteen cents for the second. A trial term of three months is required. Men who take this course are watched most carefully. Constant vigilance is being exercised to discover those who show exceptional appreciation of the work. It is not attempted to make the engineering apprentice a skilled mechanic, but to acquaint him with shop and manufacturing methods and operations. The apprentice is shifted from one department to the other, the time spent in each depending upon the man and the importance of the work.—*Abstracted from the Engineering Magazine (New York), December.*

Concerning Wireless Telegraph Transmitters.

One reason why various attempts made to approximate the resonance in wireless telegraphy have had so little practical result is due, according to Dr. Lee de Forest, to the insufficient attention that has been shown to the necessity of generating at the transmitter a long train of but slightly damped oscillations. The failure to do this has been due largely to imperfect arrangement and construction of condensers, to the spark-gap and faulty insulation in the transmitter. Rapid damping of the transmitter oscillations is due to two causes—first, losses due to radiations from the antenna, which are considered useful and necessary; and, second, losses resulting from leakage, heat and dielectric hysteresis. To prevent leakage, the antenna should be most carefully insulated from the supporting mast. A petticoat insulator giving a large and dry surface should intervene between the wire and its support. Dust and moisture are fatal to good insulation. If the air is moist, invisible brush leakage from the antenna gives the effect of a large fictitious capacity between the antenna and earth, greatly increasing its natural period of oscillation of the antenna and throwing the sending apparatus out of tune. This apparent capacity, moreover, represents a large energy loss not recoverable, and produces additional damping to the oscillation. The brush leakage, which takes place from the edge glass condensers in air, causes an apparent increase in the capacity. This leakage acts as buffers for an impulsive high-potential charging of the condenser, and thus saves the dielectric from puncture, but produces great damping, and should not be allowed. There is also an appreciable inductance in a battery of Leyden jars, when these are connected up as closely as possible. The author recommends arranging the jars in a circle, with connecting wires of equal length. This allows the battery to discharge as a unit. The heating of the spark-gap indicates that a loss of energy takes place there; and the wider the gap, the greater the loss. To reduce the gap, while maintaining the requisite high potential, a series of small gaps between balls or discs of small curvature may be used. With a one-kilowatt transmitter it is easily possible to obtain a reading on a hot-wire ammeter inserted in the antenna, of over two amperes, and five to ten times as much in the closed oscillating circuit itself. This, with 20,000 volts applied at the condenser jars, gives, roughly, a calculation of about seventy kilowatts. This nominally is explained by the fact that, during a brief hundred-thousandth of a second, the energy put into the circuit at a one-kilowatt rate is radiated at a rate enormously greater. The test is a clear and convincing demonstration of the enormous quantities of energy which a small transmitter is radiating, and of the amount which the generator would be called on to supply, could the much-desired undamped wave train be obtained. In view of the above considerations, it is not difficult to point out the fallacy of certain calculations which are often given to show the sensitiveness of a coherer or other wave detector.—*Abstracted from the Electrician (London), November 27.*

Switches for Opening High-Potential Circuits Under Load.

Several types of air-break switches have been developed in Europe for use in opening a high-potential circuit under load, without the formation of a destructive arc. When an arc is formed between two points, much heat is evolved; but if the arc can be prevented from maintaining a fixed position, the switch contacts are not heated sufficiently to be damaged. Therefore, a switch which will cause the arc to shift its position continuously until broken will not be damaged if the circuit is open while current is flowing. To accomplish this a switch may be designed upon the principles of the Siemens diverging horn lightning arrester. Thus, if two curved arms, arranged to have their upper ends diverging, are placed so that they can be brought in contact or separated, they will form a very effective high-tension switch. The simple action of separating the two arms by rotating either one or both of them about their lower extremities, opens the circuit and forms an arc, which, due to the tendency of the heated column of air to rise, is shifted upward along the diverging ends of the switch arms until it breaks. This principle has been used by Voight & Haeffner. The switch, in its final form, consists of a bell crank switch arm, having at one end a wooden operating rod, and at the other end an upwardly projecting horn. This arm is mounted upon an insulator, and, when lowered to a horizontal position, makes contact between the terminals of the line, which are supported upon two other insulators. One of these has a contact strip, which preserves contact with the arm throughout its motion, while the other has a strip extending vertically, which forms the other one of the pair of horns. Another type of switch, made by Schückert & Company, consists of two stationary diverging horns separated some distance. Contact is made between these by a metal rod bent into the form of a delta, which may be moved in a vertical direction. When it is lowered it opens the circuit on each side, forming two arcs between two pairs of diverging horns. Still another type of switch, made by Kummer & Company, consists of a pair of switch jaws, upon which are mounted two long, flexible contact pieces. When the jaws are separated by an arrangement of levers, the contact pieces are brought together and engage. As the jaws are moved apart, the two strips bend until, at a certain point, they slip by each other, making a very quick, long break.—*Translated and abstracted from the Elektrotechnischer Anzieger (Berlin), November 19.*

The Committee on Steam Turbines of the National Electric Light Association.

The National Electric Light Association's committee for investigating steam turbines, of which Mr. William C. L. Eglin, of Philadelphia, is chairman, has already accumulated a large amount of very valuable data on steam turbines, and will publish in its report a full description of the turbines manufactured in this country; it will also publish expressions of opinion from some of the leading European engineers concerning the use of the steam turbine and the field it occupies in Europe. This report will be quite voluminous, and will undoubtedly give more interesting information than has yet been published. It is the expectation of the committee that this report will be in the form of a bound volume prepared for distribution at the twenty-seventh convention of the association, to be held in Boston in May.

INDUSTRIAL SECTION.

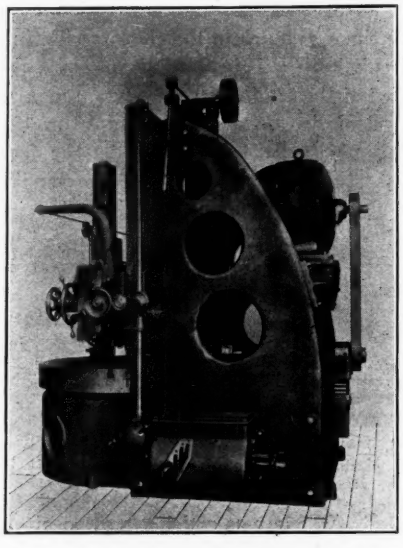
ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Fifty-one-Inch Boring and Turning Mill with Motor Drive.

Boring mills, for one reason or another, have seemed to present more difficulties in the way of a favorable application of individual motor drives that almost any other class of machine tools. Heretofore nearly all the designs that have been advanced have placed the motor outside of the machine, where it occupied useful floor space. Even when it has been mounted upon the frame it has usually been in a protruding position, or where it was not easily accessible, or was an obstruction to the accessibility of other important parts. The arrangement illustrated herewith is one of the latest and most satisfactory schemes yet devised, as it overcomes or compromises on most of the former objections.

The tool represents a fifty-one-inch boring and turning mill as built by the Baush Machine Tool Company, of Springfield, Mass., and the motor the Crocker-Wheeler fifteen-horse-power semi-enclosed form I machine. The drive is communicated to a modified cone pulley shaft through a Renold silent chain, two and one-half inches wide, with a speed reduction of 3 to 2. There are further three gear changes, the total reductions of speed for each from motor spindle to table being 14 to 1, 45 to 1 and 98 to 1, respectively. With either gear combination the motor, which is supplied with current on a four-wire multiple-voltage system, is capable of twenty-one speeds in either direction, varying from 1,065 to 106 revolutions per minute. It is not intended, however, to use motor speeds lower than those necessary to give the table the same speed that the next slower gear combination would allow at top motor speed, except on the slowest combination, as it would entail a sacrifice in power. At the highest speed of the motor the fastest speed of the table is 76.3 revolutions per minute, and the slowest, 10.9, or with the lowest motor speed the slowest possible speed of the table is one revolution per minute.

The tool has a capacity for swinging work fifty-one and one-half inches in diameter and forty inches high. The face-plate is fifty-one inches in diameter and is unusually well supported, having an outer bearing on the under side nearly equal to its diameter and another under the centre on the outer edge of the spindle. The height of the face-plate from the floor is thirty inches and the diameter of its spindle ten inches. A hole through the centre of the latter allows the chips to fall under the mill, from where they may be easily removed. In place of the face-plate, a combined independent and universal chuck may be substituted, the two being made interchangeable. The distance between the uprights is forty-six and one-half inches and the traverse of the tool is twenty-four inches. By the manipulation of the lever seen near the top of the machine, the cross-rail may be raised and lowered by power without revolving the face-plate. The cross-rail is deeply arched with double-walled back and large wearing surfaces. The saddles are



FIFTY-ONE-INCH BORING AND TURNING MILL, WITH MOTOR DRIVE.

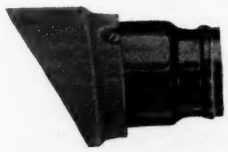
attached to steel feed screws by split nuts which can be opened and a rapid movement obtained by rack and pinion engaging a steel rack on the cross-rail. For feeding and thread cutting the saddles are arranged with Hendey-Norton gear-changing device, by means of which fifteen positive rates of feed can be obtained on each saddle, both vertical and horizontal, and the changing can be made instantly, while running.

Strength, compactness and rapid producing capacity are prominent features of the tool as equipped in the manner described. The one illustrated is installed in the Pittsburg & Lake Erie Railroad shops, at McKees Rocks, Pa., where nearly all the machine tools have individual motor drive and those requiring various speeds are supplied on the Crocker-Wheeler multiple voltage system of current supply.

Angle Wall Sockets.

The Marshall-Sanders Company, Boston, Mass., has just put upon the market a line of angle wall sockets, one of which is shown in the accompanying illustration.

These goods are made by the well-known automatic process of the Marshall-Sanders Company and embrace all the well-known forms of sockets, Edison,



ANGLE WALL SOCKET.

T.-H. and Westinghouse bases; key and keyless.

The Marshall-Sanders Company has an abundant stock on hand for immediate delivery.

The Susquehanna Development.

It is announced that Mr. Anthony N. Brady, of New York, and associates have taken over $1,000,000 stock in the United Electric Light and Power Company, of Baltimore, Md.

Plans for the power plant at Conowingo, on the Susquehanna, have been completed and routes for the cables to Baltimore, Havre de Grace, Elkton and other towns in Maryland, Pennsylvania and Delaware. This new interest is expected to assure an early completion of the power project.

BOOK REVIEW.

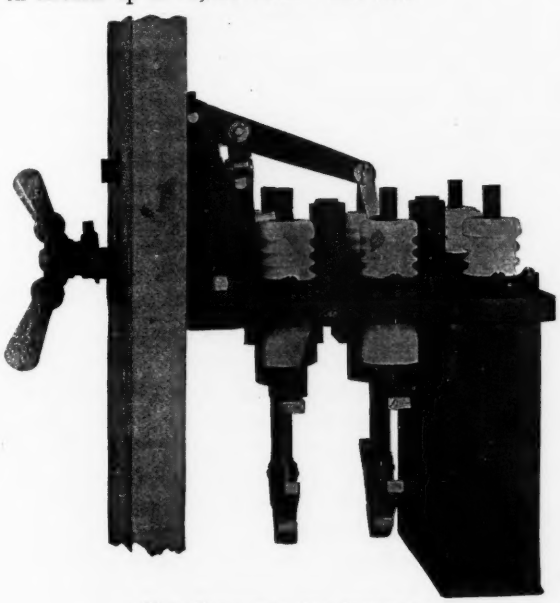
"Care and Handling of Electric Plants." Norman H. Schneider. New York. Spon & Chamberlain. Flexible leather. 116 pages. 4¼ by 6¾ inches. 66 original drawings. Supplied by the ELECTRICAL REVIEW at $1.

This manual is intended as a handbook of practical information for those who are called upon to operate a commercial or military electric plant without having had previous experience. It is written with the aid of notes actually obtained in handling the apparatus described. The author calls particular attention to the chapter on incandescent lamps, as this subject is fully taken up.

High-Potential Oil Switches.

The increasing use of high potentials has presented many serious problems in switching and the protection of the generating apparatus from dangerous overloads. The oil-break type, in which the switches and all live metal parts are immersed in oil, is generally conceded to be the best form of switch for handling high voltages, and a recent development of this type, designed by the Hartman Circuit-Breaker Company, of Mansfield, Ohio, is shown in the accompanying illustration.

This is a view of a three-pole, double-break oil switch designed for installing on the back of the panel, and to be used on circuits up to 11,000 volts. The view shows the switches in the "off" position, with one of the switches enclosed in an oil tank. Each pole of the switch is immersed in a separate tank, which is entirely independent of the adjacent ones and can be readily removed without in any way interfering with the others. The tanks are lined with insulating material which is formed in such a way that there is just sufficient space for the free vertical movement of the switches, and the quantity of oil used is thus reduced to the minimum.



HIGH-POTENTIAL OIL SWITCH.

A distinct feature in this oil switch is found in the use of the laminated or brush form of contact, which greatly increases the current-carrying efficiency of the switch and also entirely prevents "freezing" or sticking at critical periods. These contacts are protected by final arcing plates, which, with the corresponding plates on the terminal blocks, are removable and can be readily replaced should they become burnt away in the course of time. The form of contact which is used and the isolation of the switches in separate compartments give the switch a very large breaking capacity.

The movable parts of the switch are controlled by means of specially treated wooden rods, which are fastened at their upper ends to a common cross-bar. They are held in normal position by means of a toggle lock. The switch is opened by giving the handle a slight turn in the direction opposite to that taken in closing. This will cause the toggle to move past the centre and the switches will then open free of the controlling handle—producing an absolutely quick break.

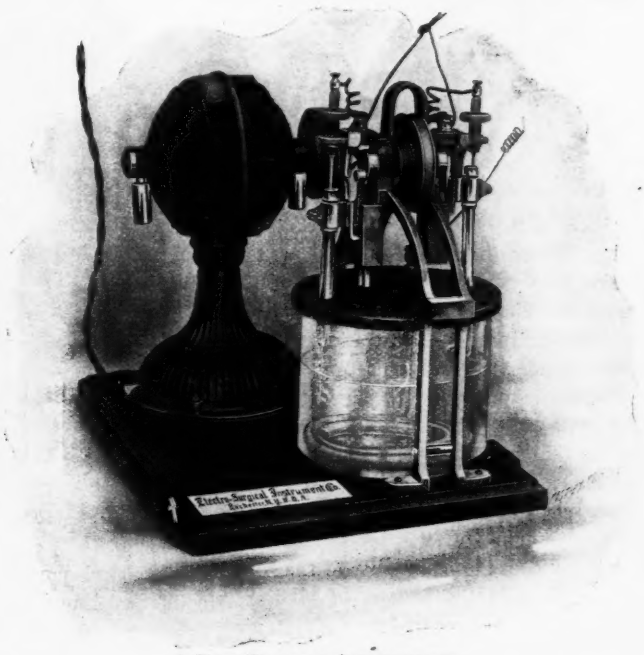
Another form of this switch is made with an automatic overload attachment. There are usually two tripping coils provided for a three-pole breaker, but it can be constructed with a tripping coil in each line. In all cases the operation of any one tripping coil will break all lines. The distinctive feature of this overload attachment lies in the fact that the tripping coils are energized by current from the high-potential circuit, and the use of series transformers in connection with the circuit-breaker is entirely avoided. The tripping coils instead of being located on the front of the panel, as is commonly the case, are mounted by means of special porcelain insulators on the carrying-frame itself. They are separated from each other by barriers of insulating material, and the method of insulation throughout is of the highest order. The overload attachment has other distinctive features, one of the most important of which is that it can not be held closed while an overload exists on any line.

This apparatus is also constructed with remote electrical control, to be installed apart from the switchboard and to be opened and closed from a distance. The operating current may be derived from the exciters, a storage battery or any convenient source of direct-current supply at from 110 to 500 volts. The remote control attachment is very reliable and it adds but little to the cost of the installation.

A New Current Interrupter.

A new current interrupter has been patented by Mr. T. A. Houghton, of Rochester, N. Y., who has assigned it to the Electro-Surgical Instrument Company, also of that city.

This interrupter is designed particularly to reduce the amount of current flowing through the coil to a minimum, giving, at the same time, heavy sparks on from one-quarter of an ampere to four or five amperes. The interrupter is double in all of its working parts, which are motor-driven, so that there is always an alternate action, the break being made at both the binding-posts and in the liquid, so that in one revolution of the shaft one wire is exposed to the liquid and another exposed to the mechanical break. The combination of the rapid mechanical and electrolytic action reduces to a minimum the current used.



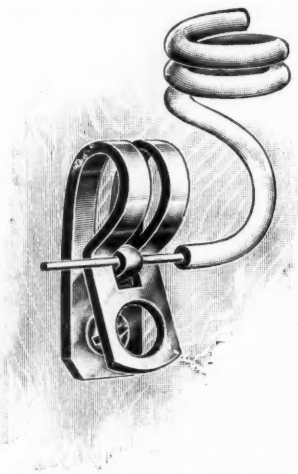
A NEW CURRENT INTERRUPTER.

An important feature of this apparatus, the inventor states, is its ability to be operated very slowly, giving momentary surgings of current through X-ray tubes, and coming slowly to a maximum, then slowly receding to a minimum. For skiagraphic work it is stated that very clear negatives have been made with but five of these surges.

The interrupter can be used with other coils, and will take the place of a static machine for therapeutic work. It is also valuable in connection with transformers, making an efficient substitute for the rotary alternator used in transforming direct current into current suitable for cautery work, and providing a convenient means of regulating the current strength, taking the place of a rheostat and rotary alternator for this work.

Spring Binding-Post.

The Fahnestock Transmitter Company, 74 Cortlandt street, New York city, is introducing a new form of binding-



NEW FORM OF SPRING BINDING-POST.

post, in which the set screw or screw nut is done away with and the wire is held by the action of a spring. This is shown in the accompanying illustration. The maker claims that with this construction the wire can not work or jar loose, and that contact is always ensured, because of the constant pressure exerted on the wire. The maker also claims that a wire can be connected or disconnected in one-tenth of the time it takes to set a screw-post, and that there is also no possibility of the wire being broken in the process of binding. The company is prepared to supply this post for all kinds of electrical work, including battery connections.

New Electric Lighting Specialties.

The Banner Electric Company, of Youngstown, Ohio, manufacturer of the "Banner" incandescent lamp, has recently

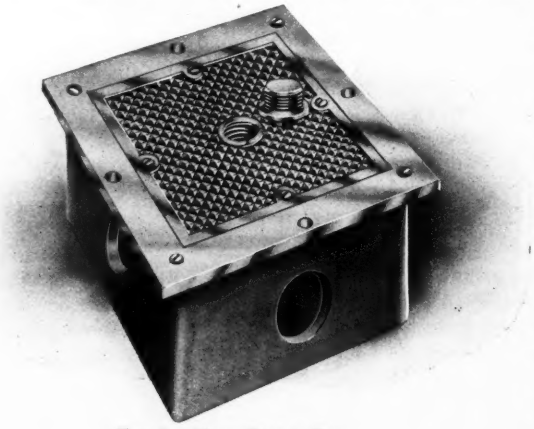


FIG. 2.—NEW FLOOR BOX.

placed on the market several new specialties. The accompanying illustrations show two of these. Fig. 1 is a new weatherproof cutout. Fig. 2 is a new floor box.

The weatherproof cutout is an interesting device used principally in connection with alternating arc lamp service. The contact point can not be reached except by means of the fuse tubes shown, so that a heavier fuse than should be used can not be connected. In this way the lamp is protected from excessive current. The device can, however, be used in many other ways where some protection is needed and can be afforded by using fuses of fixed capacity. The base of this cutout

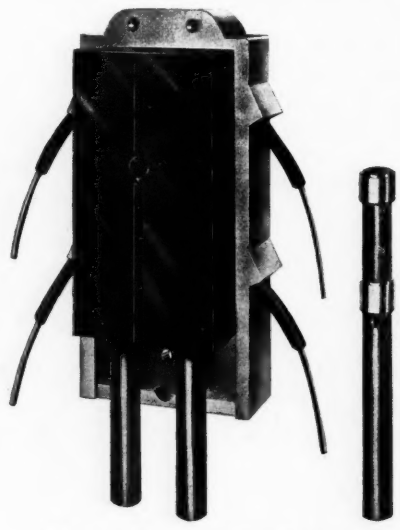


FIG. 1.—WEATHERPROOF CUTOUT.

is of glazed porcelain, and the contact points are round spring clips. The fuse tubes are of heavy hard fibre, carrying copper ferules, to which the fuses are soldered, the fuse passing through the side of the tube from one ferule to another.

The maker states that this arrangement is such that the fuse can not jar loose or drop out when inserted in the clips, and a good contact is always assured.

These cutouts are designed for 250 volts and any required capacity up to thirty amperes. The positive and negative poles are separated by a thick wall of porcelain, minimizing the possibility of short-circuit. The cover is of enameled galvanized iron bolted to the porcelain and cemented securely around the edges so as to be waterproof. The inleading wires are soldered to the spring clips.

The floor box shown is designed for conduit work, and is to be used by the new Government Bureau of Standards in its laboratory, which has recently been built at Washington. The lower part of the box is of cast iron, the cover being of polished brass. The centre field is finished in small, raised diamond-shaped figures. The centre plug screws in from the bottom of the plate, and when in place comes flush with the top side. A rubber gasket is used between the brass cover and the iron box body, so as to make it watertight.

An Elevator Alarm System.

The National Oil Burner and Equipment Company, St. Louis, Mo., is introducing a system consisting of a set of electrical alarms located on each floor of a building which are automatically sounded by a moving elevator in advance of and announcing the approach of the elevator, whether it is going up or down.

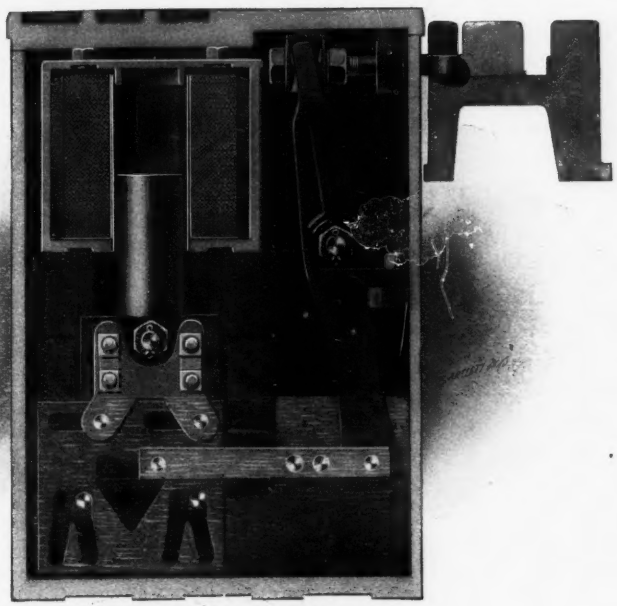
Three contact plates are fastened on or near to the guides of the elevator of such length and so placed as to sound the alarm the desired length of time and at the required intervals. The circuit is made by a roller contact with a spring on the platform of the car. The platform of the car is in connection with a thin cable, one end of which is carried on the car and the other end is stationary at a point midway between the extreme up and down position. From this point it is connected to a battery.

From the contact plates the guide wires are connected to the alarm bells. These are connected in turn to two more circuits which are alternately switched to the battery, as the car moves up or down. This switch is operated by the tiller rope, which by suitable levers throw the switch simultaneously with the reversal of the machinery. This system was designed by Mr. Joseph G. Branch, general inspector of boilers and elevators for St. Louis, Mo.

News comes from Brussels that the Belgian and the French governments have made an agreement relating to the establishment of telegraph communication between the Congo Free States and the French Congo. According to this agreement a submarine cable is to be laid at Stanley Pool which will connect the telegraph offices of Brazaville and Kinchassa. The cost of construction is to be borne equally by the two countries. It is proposed to use Morse registering apparatus in the two stations. The tariff is fixed at five cents a word with a minimum rate of twenty cents per message. The agreement stipulates that press despatches will pay only half rates.

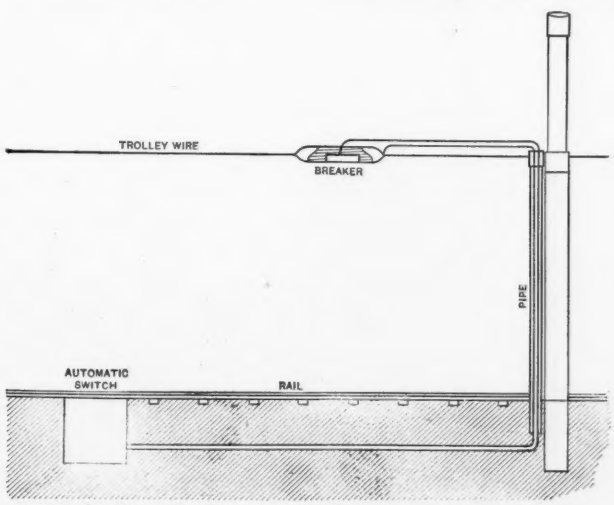
A New Automatic Track Switch for Electric Roads.

The American Automatic Switch Company, 120 and 122 Liberty street, New York city, has devised a new switch-operating mechanism for turning a railroad switch automatically. This, the company claims, is simple in construction, positive in operation, has no exposed contact points, no drainage to sewers, and no complicated mechanism. The accompanying illustrations give a good idea of the operation of the switch.



AUTOMATIC SWITCH MECHANISM.

The mechanism is enclosed in a sealed box, and the magnet is immersed in a special oil in a sealed case, giving it absolute protection from moisture.

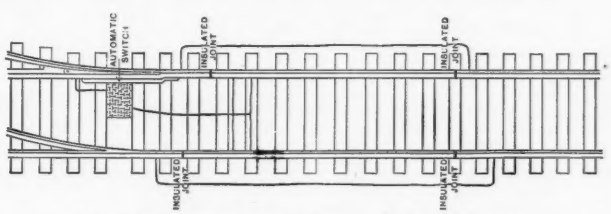


TROLLEY CONNECTION FOR AUTOMATIC TRACK SWITCH.

This automatic track switch is, of course, capable of being operated either with a trolley or rail installation. Where a trolley is used, a breaker is placed in the circuit, the current from the breaker actuating the electromagnet at the proper time. To operate the switch, the motorman must leave the controller at one or two points while passing over the breaker or the insulated rail, while if the switch is in proper position, the power is shut off and the car is coasted over the insulated rail or the breaker. A study of the illustration will aid in understanding the operation of the system.

The motorman brings his car to a point where it is possible to see whether the switch is in proper place for either continuing straight ahead or making a turnout. If the switch must be turned, he approaches the breaker with a small amount of power turned on, and this current flowing through the breaker actuates the electromagnet. The electromagnet pulls up the cam, which causes the switch to close, and the car proceeds. The next car along may wish to continue in the direction taken by the preceding car, and in this case the motorman cuts off power and passes over the breaker without actuating the electromagnet. The next car that wishes to change the direction repeats the operation of the first car, the switch being automatically opened or closed as the occasion demands.

There are no springs connected with the mechanism, the levers, cam and electromagnet being all there are to the apparatus. The manufacturer states that the switch has been in use on the system of the Metropolitan Street Railway Company, New York city, and has also been used by several other prominent roads, giving satisfaction in each case.



RAIL CONNECTION FOR AUTOMATIC TRACK SWITCH.

The Metric System.

Since the question of the metric system was discussed before the British Institution of Electrical Engineers last session, it has been debated with more or less vigor in many another assembly in different parts of the country. It is understood that a conference will be held in London at the end of the present month of representatives of local authorities who have come to a decision by resolution on the subject. The conference will be invited to appoint a representative deputation to meet the Board of Trade to discuss the question of the compulsory use of metric weights and measures in Great Britain.

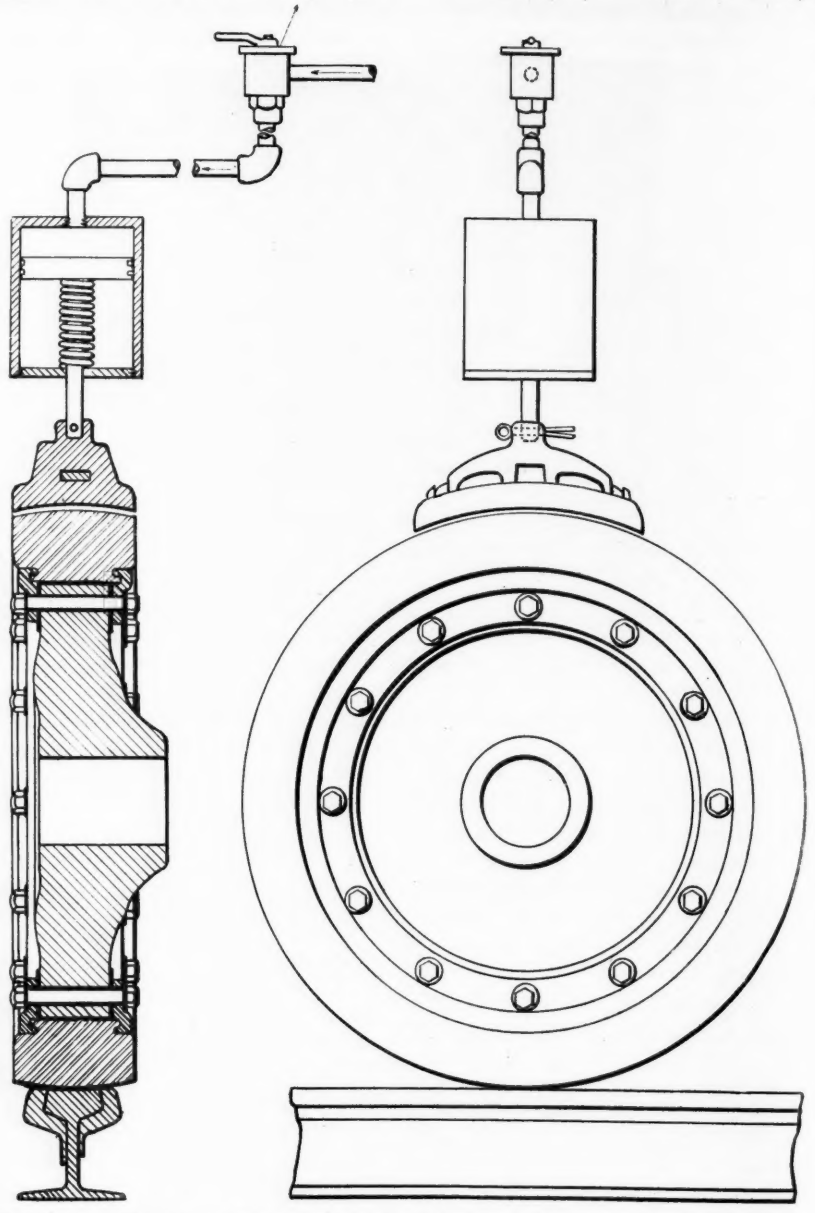
Sleet Cutter and Contact for Third-Rail Systems.

One of the difficulties in the operation of third-rail systems during the winter season has been the deposit of sleet and ice at the time of storm, this condition sometimes necessitating the tying up of the entire system under this contingency. Many efforts have been made to overcome this, and the accompanying illustration shows a device which has been placed on the market by the Kinsman Electric Railway and Supply Company, of New York city.

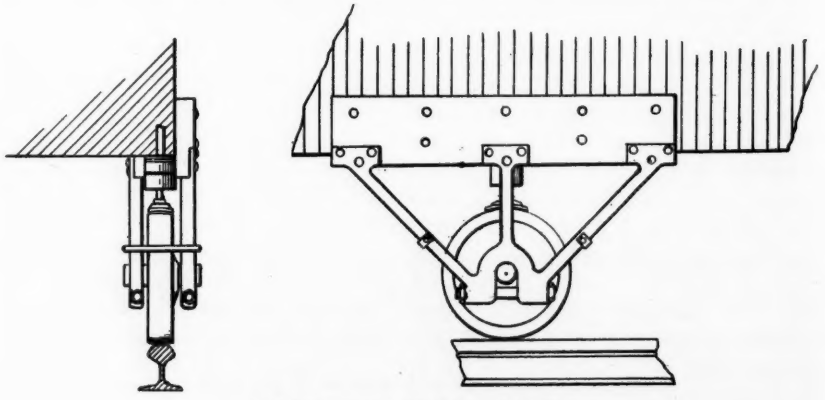
The Kinsman sleet cutter and contact for "third-rail" roads consists of an ordinary car wheel so constructed as to travel upon the "third rail" as an idler, except when under pressure from the air cylinder, controllable from the motorman's cab. The introduction of compressed air into this cylinder or electromagnetic controller forces a brake shoe carried above the wheel at the end of a piston rod (as shown in the accompanying cut) into contact with the periphery of the wheel. Upon a car traveling at ten miles an hour a given pressure from the cylinder retards the motion of the idler or contact wheel to, say, six miles an hour. The differential motion thus produced, grinds or strips the "third rail" of ice or any other obstruction, giving a clean surface for the following contact wheel or shoe. The wheel is fitted for different sizes of rail, as shown in the illustration, and has a wearing surface of three times its diameter, which in the case of a twenty-eight-inch car wheel is equivalent to something over eighty-four inches, the ordinary scraper has a wearing surface of from three to six inches, and can only be used with the pressure resulting from its own weight.

The Kinsman arrangement is very durable in that its flexible hanging and cushion effect of the air cylinder permits it to take a raised joint or other obstruction without injury.

Where the wheel is used only as a scraper a solid second-hand car wheel serves the purpose. Where it is used as a contact wheel as well as a scraper it needs to be insulated as shown in the accompanying illustration. Where it is found undesirable to put the responsibility for the pressure upon the motorman, it is regulated automatically by the amount of current the shoe is taking, as, for instance, a limited quantity of current allows the air valve to open, bringing full pressure upon the wheel. The amount of air entering the cylinder is decreased by a stronger current, partially closing the inlet, and at the same time permitting of a certain amount of escape. A substantial advantage is found in the absence of danger from flying pieces of metal as from other forms of cleaners.



SECTION AND ELEVATION, SHOWING METHOD OF APPLYING INSULATED RIM SLEET CUTTER.



A NEW THIRD-RAIL SLEET CUTTER.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

HONOLULU RAPID TRANSIT—The Honolulu Rapid Transit Company, which operates an extensive electric traction system in Honolulu, Hawaiian Islands, has acquired the horse car lines hitherto operated by the Hawaiian Tramways Company—a British capitalized concern—and will convert a large portion of the road into electric motive power.

SOUTH AMERICAN POWER PLANT—The Ytu Light and Power Company is to construct a transmission plant for the purpose of supplying electric energy to Ytu, a small city in the state of Sao Paulo, Brazil, and surrounding districts. Contracts have just been placed in the market for various equipments. The plant will be located at a place called Cachveria das Larvas, about half a mile from Ytu.

LIGHT AND POWER MERGER—A merger of the electric lighting and power plants in the coke regions, and the Pittsburg, McKeesport & Connellsville Railway system, has been effected, and an application for a charter for the combined interests will be made at Harrisburg, December 31. It is said that the capitalization will be considerably over $5,000,000. The new company, which will be known as the Western Pennsylvania Railways Company, will be in control of the entire lighting, power and street railway systems of Westmoreland and Fayette counties, as well as part of the trolley system of Allegheny County.

LONG ELECTRIC RAILWAY IN MEXICO—An electric railway is to be built by an American syndicate between the cities of Guaymas and Chihuahua, a distance of 270 miles. It will commence at Guaymas and pass through the towns of Misa, San Marcial, Pesquerin, Ononas, Tuluaca and Temosachio, terminating at Chihuahua. It will cross three rivers, the Metape at San Marcial, the Rio Yaqui close to the city of Ononas and the El Rosario at Tuluaca. The object of building the road is to do away with the expense of mule trains. G. A. Albert, a former banker of Utica, N. Y., is chiefly concerned in the scheme. He is now on his way to Guaymas.

IMPORTANT TELEPHONE OPINION—All telephone companies doing business in Chicago can be compelled by the council to enclose in boxes or booths all public telephones in the city limits, even if the telephones are used for talks with persons outside of the city or state limits. The city has the right to pass an ordinance requiring the Chicago Telephone Company to return coins dropped in the slot unless the person calling succeeds in conversing with the person called for. These principles are laid down in an opinion drawn up by Assistant Corporation Counsel Maclay Hoyne, and approved by Corporation Counsel Tolman, for the judiciary committee. As to the nickel dropped into the slot, however, the law department advises the committee that the passing of a returning ordinance might end the city's right to further compensation from the company. This amounted last year to $85,000.

BIG SYSTEM OF TELEPHONES—One of the most extensive private telephone systems of the country has about been completed by the Carnegie Steel Company. This company for years has had all of its plants connected with the general offices in Pittsburg by its own telephones, and by this means has been able to keep all department heads in instant touch with the works. As the company passed to the control of the United States Steel Corporation and other companies, such as the National Steel Company, the American Steel Hoop Company and portions of the Union Steel Company were merged with it, the telephone system became purely local in its service and failed to give the heads of the various departments that same facility for directing that was had before. The recent arrangement of the company calls for the extending of the telephone wires not only to all local plants, but to all of the plants of the merged companies, and, in all cases, with a direct connection in the main telephone room in the Carnegie Building. This gives the company telephones of its own, extending through the Mahoning and Shenango valleys and to Sharon. Every plant, furnace and other feature of the big underlying corporation will be taken into the general service. Altogether there are over 1,000 telephones to be in the completed service, and miles of special wires have had to be strung for the system.

NEW TRACTION COMPANY IN INDIANA—The Vincennes, West Baden & Louisville Traction Company has filed articles of incorporation with the secretary of state. This is one of the most important traction ventures ever undertaken in Indiana. The plan is to build an electric and steam railroad from Vincennes to Jasper, Dubois County; from there to West Baden and ultimately to Louisville, Ky. The directors of the company are John L. Griffiths, of Indianapolis; A. Norvale, of Cincinnati; Bomar Traylor, of Jasper; Robert M. Gray, of Otwell, Pike County; John O. Davis, of Petersburg; George W. H. Roush, Edwin P. Millett and Thomas H. Adams, of Vincennes, and Elmore F. Cox, of Worthington. The company is capitalized at $1,500,000 and has been financed by the Municipal Bond and Securities Company, of Cincinnati, which firm is the fiscal agent of the enterprise. Eugene Calhoun, an expert traction engineer of Buffalo, has surveyed the proposed route of the road, and has made a fifty-page report to the promoters. In his report he says the scheme "presents the most attractive traction proposition in the country." The promoters of the line say it will open up 250,000 acres of coal lands in southern Indiana, and it is stated that three companies are ready to open mines as soon as the road is built. It is understood that a right of way has been secured between Vincennes and Jasper, a distance of about forty-three miles, and that work on the construction will be completed within ninety days. It is the purpose to build a track that will accommodate a steam locomotive, and one of the plans of the company is to some day haul freight trains over the line by steam. The directors of the company have organized at Vincennes.

LEGAL NOTE.

PENNSYLVANIA-WESTERN UNION DISPUTE GOES TO FEDERAL COURT—Way has been opened for the taking of the dispute between the Pennsylvania Railroad and the Western Union Telegraph Company to the United States Circuit Court of Appeals, and it is announced that this will be done immediately. This action has been made possible through an agreement of counsel for both sides, that there will be no more destruction of lines until the case has been decided. The Western Union company filed in the United States Circuit Court at Pittsburg an amended bill of complaint against the Pennsylvania company, in regard to its notice of termination of contract, given June 2, 1902, and expiring June 2, 1903. This bill complains particularly of the contract between the Western Union and the Pennsylvania companies for rights along the line of the Cleveland & Pittsburg Railroad. A demurrer to this amended bill was filed on December 2, and was sustained by Judge Buffington. A decree was also entered by Judge Buffington, dismissing the complaint. This placed the matter in regard to the Cleveland & Pittsburg Railroad and other of the Pennsylvania lines west in the same condition as the decision of Judge Acheson some time ago placed it in the suit of the Western Union company against the Pennsylvania Railroad Company, when all the poles of the telegraph company along the railroad's right of way were cut down. By the agreement of counsel, however, there was no radical action taken by the railroad, as it is desired by both sides to get a decision on the matter from the United States Court of Appeals. The decree entered by Judge Buffington places the matter in position to be taken to the higher court.

AUTOMOBILE NOTE.

ANNUAL BANQUET OF THE AUTOMOBILE CLUB OF AMERICA—On Saturday evening, January 23, 1904, the Automobile Club of America will hold its fifth annual banquet at the Waldorf-Astoria, New York city. The governors are in receipt of acceptances to invitations sent to several well-known speakers, and it is expected that all of the members will give their hearty support to this most important of the club's dinners. Mr. Homer W. Hedge is chairman of the house committee.

ELECTRIC RAILWAYS.

ROANOKE, VA.—The Roanoke Railway and Electric Company and others are reported to be considering a plan to build an incline railway to the top of Mill mountain.

EVANSVILLE, IND.—A move is on foot to build a traction line from Tell City to Cannelton, a distance of four miles. Cannelton and Tell City capitalists are said to be back of this plan.

VINELAND, N. J.—It is said that a trolley line direct from this place to Bridgeton will be built in the spring. The line will connect Norma, Alliance, Rosenhayn and Carmel with Bridgeton and Vineland.

MARSHALL, MO.—Steps have been taken for the construction of a line of electric railroad from Sedalia to Miami by way of Marshall, a distance of fifty miles. The proposed road will traverse the best agricultural country in Missouri.

ATLANTA, GA.—The Birmingham Railway, Light and Power Company has put into operation its addition to the Powderly line, making a new electric route between this city and Bessemer and establishing a loop twenty-five miles around.

PENN YAN, N. Y.—The towns of Urbana and Pulteney have granted the franchise asked for by the promoters of the proposed electric railroad that is to run from Savona to Hammondsport, and thence along the west coast of Lake Keuka to Branchport.

VIRGINIA, MONT.—Eastern capitalists are said to be interested in a plan to construct an electric railway connecting this city and the Ruby valley with Dillon and the Oregon Short Line Railway. The cost of the project is estimated at $150,000, and it is said that work will begin in the spring.

SPRINGFIELD, ILL.—The secretary of state has licensed the incorporation of the Decatur Railway and Light Company, capitalized at $1,500,000, to operate a street railway, heat, light and power plant. This is said to be merely a reorganization of the Decatur properties owned by the McKinley syndicate.

SEA ISLE CITY, N. J.—Philadelphia capitalists are said to be interested in the construction of a line of electric railroad to run from Beesley's Point to Cape May City along the Seashore road, a distance of thirty miles. Another road will be built from this city to Millville, a distance of twenty-eight miles.

GLENS FALLS, N. Y.—The Hudson Valley Railway Company is about to install a new storage battery station at Caldwell. The building will be twenty-five by sixty-eight feet, and 267 cells will be included in the battery, with a storage capacity of 700 kilowatts. The cost of the plant will be approximately $20,000.

NORFOLK, VA.—At a meeting of the stockholders of the Chesapeake Transit Company, the capital stock was increased from $623,000 to $1,000,000. The company operates a trolley line from here to Lynn Haven Inlet, Cape Henry and Virginia Beach, and proposes to double-track the entire distance of twenty-four miles.

CONNERSVILLE, IND.—Local capitalists and business men are interested in the formation of a company for the purpose of promoting an electric belt line to include the towns of Laurel, Metamora, Brookville, Fairfield, Lyons Station, Milton, Bentonville, Glenwood and Orange, with the central station and power-house at Connersville.

SEYMOUR, IND.—The townships of Brownston and Driftwood have voted in favor of a two per cent subsidy for the Indiana Central Electric Railroad Company. The tax in the two townships will amount to about $30,000. In Vernon township, Jennings County, it was also voted to donate a two per cent tax aid to the Hubbard Yoder-Rominger interurban line from Columbus to Madison.

CHAMPAIGN, ILL.—Contracts have been let for the construction of the interurban line between Decatur and Springfield. The firm having the contract has just completed the work at Carlinville, on that part of the line between Springfield and St. Louis, and will move its men to a point near Decatur. Enough material is on hand to complete the road to Springfield, and work will continue all winter.

WASHINGTON, D. C.—About $80,000 has been subscribed for the new electric railway through Rappahannock and Culpepper counties, in Virginia, and it is now stated that the line will surely be built. It will start at Washington, the county seat of Rappahannock County, and will run to Culpepper, where it will connect with the Southern and Chesapeake & Ohio railways for this city. The line will eventually be extended along the Rappahannock river.

LITTLE ROCK, ARK.—The state railway incorporation board has granted the application of the Little Rock Nothern Railway Company for a charter, under which it purposes to build a railroad from Little Rock, Ark., to Springfield, Mo., a distance of 280 miles. The board of directors consists of Andrew Johnson, W. W. Dickinson, John M. Rose, Charles T. Coleman and H. M. Armistead, of Little Rock, and the company's authorized capital is $11,000,000.

WILMINGTON, DEL.—Officials of the Middletown & Odessa Railway Company state that the company will build a line down the state in the spring. The new line, as proposed, will pass through Townsend, Blackbird, Clayton and Smyrna, and later may run to points further south. After this extension is completed it is likely that the road will be connected with the New Castle & Delaware City line, making a continuous trolley road from Wilmington to Smyrna.

MOLINE, ILL.—A trust deed in favor of the Illinois Trust and Savings Bank, of Chicago, has been filed in the office of the circuit clerk by the Mississippi Valley Traction Company, to cover an issue of bonds in the sum of $600,000. The filing of the deed represents one of the early transactions of the new company in taking over the property of the Moline, East Moline & Watertown interurban road. The bonds are issued to cover the transfer and to provide a fund with which to carry on the plans of the new company to extend the present line of the Watertown interurban.

MIDDLEBORO, MASS.—The first corporation meeting of the Plymouth, Carver & Wareham Street Railway Company resulted in the election of the following officers: president, Henry S. Griffith, Carver; vice-president, William S. Kyle, Plymouth; secretary and treasurer, James B. Collingwood, Plymouth. The route of the proposed road is from the Tremont station of the New York, New Haven & Hartford Railroad, in West Wareham, through South Carver, Centre Carver, Wenham and Darby to Plymouth, a distance of about fourteen miles. It is proposed to have the line in operation early next spring.

GOSHEN, IND.—Local capitalists are organizing a company for the purpose of completing the last connecting link that will give South Bend, Mishawaka, Elkhart and Goshen, now closely united by the Indiana Railway Company's electric line, direct railway connection with Indianapolis. Marion capitalists are now building a line to Wabash, and a company composed of Wabash, North Manchester and Warsaw citizens have the right of way secured between Wabash and Warsaw. The twenty-four miles from Warsaw to Goshen will complete one of the best paying traction lines in Indiana, giving connection with the resorts of Winona and lake Wawasee.

WAYNESBORO, PA.—A charter has been granted to the Valley Traction Company, a company organized to combine the trolley interests in Cumberland County and Franklin County now under the control of the Cumberland Valley Railroad. The company has control of the Harrisburg & Mechanicsburg, the West Fairview & Marysville, and the White Hill & Mechanicsburg lines. It is the intention of the company to build a line from Mechanicsburg to Carlisle, connecting there with the Carlisle & Mount Holly line. A central power-house for these lines will be erected at Bridgeport. The directors of the new company are M. C. Kennedy, Chambersburg; George H. Stewwart, Chambersburg; Lyman D. Gilbert and Spencer D. Gilbert, both of Harrisburg, and Lewis S. Sadler, Carlisle.

INDIANAPOLIS, IND.—Stockholders of the new Columbus, Greensburg & Richmond Traction Company have elected the following directors: August M. Kuhn, A. K. Hollowell, of Indianapolis; M. O. Reeves, Columbus; Walter McConahy, Richmond; William P. Meyer, C. N. Wilson and H. M. Holland. The electric interurban system planned by the new company contemplates a line from Richmond to Louisville by way of Greensburg and Columbus. Connections with Indianapolis are also planned, and the company will also probably build extensions to meet the Appleyard system in Ohio. When the system has been worked out completely it is said there will be eight connections into Indianapolis. The estimated expense of the system contemplated by the company is $2,500,000. The financing of the first line from Richmond to Columbus has been practically accomplished, and it is announced that work will begin early in the spring. A power-house is to be erected at Greensburg.

ELECTRIC LIGHTING.

READING, PA.—The electric light plant at Bernville has been placed in operation.

MEMPHIS, MO.—There is some talk of installing an electric light plant at Downing.

NORWAY, IOWA—L. J. Norland and others contemplate installing an electric light plant.

NORFOLK, VA.—The Portsmouth Electric and Gas Company has been awarded a contract for street lighting.

WALNUT, IOWA—The electric light proposition voted on recently resulted in favor of a municipal plant.

GALVESTON, TEX.—San Antonio is to vote on a $200,000 bond proposition for a municipal electric light plant.

ATHENS, OHIO—The Athens board of public service has contracted for the erection of a municipal light plant, to cost $13,740.

FRESNO, CAL.—The San Joaquin Power Company has completed its new auxiliary plant, which will give it approximately 800 additional horse-power.

EATON RAPIDS, MICH.—At a special election the proposition of the city bonding for $12,000 to build an electric light plant was carried by 113 majority.

ST. LOUIS, MO.—The St. Charles Electric Light and Power Company will increase the capacity of its plant by the addition of two 500-horse-power engines.

BLOOMER, WIS.—The electric light plant has been put in operation. Power for the plant is furnished from a dam at Eagle Point, about seven miles from Bloomer.

ATLANTIC, N. J.—The Atlantic Electric Light and Power Company is making additions to its system which will provide for the increase of business during the next five years.

HARRISBURG, PA.—Notice has been filed at the state department by the Philadelphia Electric Light Company, that it has increased its capital stock from $100,000 to $2,500,000.

CAPAC, MICH.—The contract for the construction of an electric light plant for this village has been awarded. The plant is to cost $5,913, and is to be run in connection with the waterworks system.

NEVADA, MO.—The Missouri Water, Light and Traction Company has sold all of its plants and property in Nevada to the Union Water, Light and Traction Company, with headquarters at Jerseyville, Ill.

PORT HURON, MICH.—The Port Huron Light and Power Company is supplying a large amount of power to various concerns at South Park, and has decided to erect a substation and furnish the power direct from there to consumers.

WAREHOUSE POINT, CT.—The street lighting committee has made a contract with the Windsor Locks Electric Light Company to light the streets of this village and Broad Brook for a period of ten years, at a cost of $14.88 per light.

READING, PA.—The Allentown & Reading Traction Company is now running its wires from Kutztown to Lyons and Fleetwood, for the purpose of supplying these towns with electric lighting. They may be extended to Blandon during the winter.

WESSON, LA.—The city council has closed a contract with W. H. Harvey, of Memphis, to install an electric plant. The system is to consist entirely of arc lights and to be first class in all its appointments. Work is to commence as soon as possible, and is to be completed by spring.

HANNIBAL, MO.—The special committee appointed by the mayor to consider the plan of rebuilding the electric light plant will make a report to the council recommending that a proposition to issue bonds in the sum of $100,000 to rebuild the plant be submitted to a vote of the people.

LITTLE ROCK, ARK.—The contract for the power-house of the Walnut Ridge & Hoxie Light, Power and Transit Company, at Walnut Ridge, is to be let. The main building will be 48 by 105 feet, with twenty-two-foot ceiling. There will be two engines of 225 and 300 horse-power, respectively.

PATERSON, N. J.—The Plainfield Gas and Electric Company and the Somerville Lighting Company have filed an agreement merging the two concerns. The officers of the new company are H. G. Runkle, president; secretary, A. M. Young, of Bramford, Ct.; treasurer, James C. Pope, of Paterson, N. J.

PORTLAND, CT.—The Middletown Electric Light Company has decided to extend its service across the river to this town. It is said that enough subscribers have been secured to warrant the success of the venture, and the service will be gradually extended. The company is also running a line to Cromwell.

LEE, MASS.—The annual report to the state board of gas and electric light commissioners shows the Lee Electric Light Company's assets to be $64,980.94, and its liabilities $60,066.25, leaving a balance of $4,914.69. The operating expenses amounted to $6,241.45, while the income from the sale of light was $10,826.67.

JOHNSTOWN, PA.—It is expected that the plant of the Dunlo Light, Heat and Power Company will be ready for operation about the middle of January. The plant is to be a model one in every way, and will have a capacity of from 1,200 to 1,400 lights. M. G. Ashley is president of the company and John Quinn is secretary.

HACKENSACK, N. J.—The lighting plant of the Hackensack Electric Light Company, on the Hackensack river, has been destroyed by fire. The loss is not definitely known, but it is thought it amounts to more than $50,000. The building was of brick and contained much valuable machinery, which was entirely destroyed.

MACON, GA.—The new contract between the city and the Macon Railway and Light Company for lighting the city has become operative, the former five years' contract having expired. Under the former contract, the price paid by the city was $100 per lamp per year. The price under the new contract is $75 per year. The present number of lamps is 153, amounting to $15,000 per annum, exclusive of the incandescent lights used in the public buildings.

MOLINE, ILL.—At the annual meeting of the stockholders of the People's Power Company, the following officers were elected: president, C. O. Nason, Moline; vice-president, Philip Mitchell, Rock Island; secretary and manager, S. S. Davis, Rock Island; treasurer, W. L. Velie, Moline. The board of directors is now as follows: C. O. Nason, C. H. Deere, W. L. Velie, Moline; S. S. Davis, Philip Mitchell, T. B. Davis, Rock Island; A. W. Vanderveer, Davenport.

ALBANY, GA.—Charles E. Garner and Smith D. Pickett, representing the Florida capitalists who recently purchased the water power on Muckafonee creek, two miles above the city, have made a proposition to the city to furnish it with power for its water and power plants. This water power is said to be one of the finest in the state, and if the committee appointed to look into the matter awards the contract asked for, its development will be assured.

SAN FRANCISCO, CAL.—A complete transfer has been made to the San Francisco Gas and Electric Company of all the properties, including stocks, bonds, machinery and appurtenances, of the Independent Electric Light and Power Company and the Independent Gas and Power Company. This transfer consummated the sale under the terms of an agreement entered into July 2, 1903. Cash and bonds to the amount of $6,210,000 were paid to John D. and A. B. Spreckels.

NIAGARA FALLS, N. Y.—It is stated that the Electrical Development Company, one of the companies now engaged in power development work on the Canadian side of the river, will erect one of the largest power-houses on the continent. The building will be 425 feet long and 200 feet wide. It will be constructed of solid granite. Plans and specifications are now being prepared, and tenders will be called for within a short time. The building, as proposed, will cost $400,000.

SPRINGFIELD, TENN.—The Springfield Electric Light and Water Company has been organized here, the following citizens being the promoters and stockholders: William McMurry, A. B. Porter, G. S. Moore, Frank Bell, H. L. Dulin, H. Fatham, H. T. Stratton, Jr., E. B. Long, W. B. England and C. T. Tanner. The company has made a proposition to the town to furnish its water free and lights at a nominal cost, provided the town will erect a standpipe and lay water mains; also to give the town one-third of the annual gross receipts of the water plant. The company asks for a twenty-year franchise and proposes to sell its plants to the town at their actual cost if the town desires to purchase them between the date of erection and July 1, 1905.

TELEPHONE AND TELEGRAPH.

RAWLINS, WYO.—A telephone line is to be built from Walton to Kaycee.

MOLINE, MINN.—The Central Union Telephone Company has opened an exchange at East Moline.

PITTSBURG, PA.—The Huntingdon & Clearfield Telephone Company has installed an exchange at Winburn.

NEW YORK MILLS, N. Y.—The Utica Home Telephone Company has installed its system in this village.

HOKAH, MINN.—The Hokah Mound Prairie Telephone Company has been organized to build a farmers' line into Hokah.

LA CROSSE, WIS.—The Wisconsin Telephone Company will install a complete telephone system in Sparta, work to commence soon.

DES MOINES, IOWA—The Farmers' Mutual Telephone Company has been incorporated at Voorhies. J. Conroy is president and J. H. Dunn secretary.

PHILADELPHIA, PA.—A new telephone line will be built in the vicinity of Steinsville, taking in a large number of rural towns in both Berks and Lehigh counties.

DES MOINES, IOWA—The American Telegraph and Telephone Company, recently incorporated for $100,000, is now constructing a line from Waterloo to Des Moines.

SHAWNEE, O. T.—The Independent Telephone Company has completed a metallic circuit to Denison and Sherman, Tex., connecting with its main line in this city.

GREEN BAY, WIS.—The Wausauke Telephone Company is constructing a line through the town of Brazean, to extend to Oconto Falls and Gillett and then to Green Bay.

LOUISIANA, MO.—The Baffum Telephone Company, of this city, announces the completion of its new copper wire line to St. Louis, where it connects with the Kinloch system.

WILMINGTON, N. C.—The Columbia Telephone Company has been organized with the following officers: J. W. Harrelson, of Clarendon, chairman; L. Goodman, secretary.

WENONAH, N. J.—The People's Rural Telephone Company, which has been organized, expects to have its system in operation by next July. Its headquarters will be in this town.

WHEELING, W. VA.—The Belmont Telephone Company has decided to make quite extensive improvements to its system, as a result of the growth which has taken place in its business.

PATCHOGUE, N. Y.—At a meeting of the highway commissioners, the North Shore Telephone Company was granted permission to use the streets of the town for its poles and wires.

ANN ARBOR, MICH.—The Washtenaw Home Telephone Company has given a trust mortgage of $25,000 to the Luzerne County Trust Company, to secure the issue of bonds to that amount.

PORTSMOUTH, OHIO—The Portsmouth Telephone Company contemplates some extensive additions to its plant in the immediate future, in order to accommodate the large increase in business.

UNITIA, TENN.—The route for the new telephone line from here to Greenback has been surveyed and will be built shortly. Another new line has also been surveyed from here *via* Antioch to Lenoir City.

SMITHVILLE, TEX.—The Smithville Telephone Company has been organized with the following officers: H. C. Schumacker, president; V. S. Robb, vice-president, and J. M. Moore, secretary and treasurer.

HART, MICH.—At a meeting of the directors of the Oceana Telephone Company it was voted to change the name of the organization to the Lake Shore Telephone Company, and to increase the capital stock to $200,000.

PROVINCETOWN, MASS.—The Hyannis circuit and the Cotuit circuit of the Cape Cod Telephone Company's lines have been brought together, giving all the subscribers connection with Hyannis, Hyannisport, Centerville, Osterville, Marstons Mills, Cotuit and Santuit.

EXETER, N. H.—The Exeter Telephone Company's lines have been extended to Haverhill, Mass., making connection with Powpow River, Carterville, Newton, Newton Junction, Plaistow and Westville. Connection can now be had with the People's Telephone Company.

CATAWISSA, PA.—The Columbia County Telephone Company has completed traffic arrangements with the Pennsylvania Telephone Company. This is a new company which is backed by John G. McHenry, of Benton; William Masters, of Millville, and George Hummer, of Elk Grove.

AMITYVILLE, L. I.—The New York & Long Island Telephone Company, which for the past six months has been erecting a telephone line between this place and Freeport, has completed the work and established service between the two points. The work of extending the line to Babylon has reached a point near Lindenhurst.

SAN ANTONIO, TEX.—At the annual meeting of the stockholders of the San Antonio Telephone Company, all the officers and directors were reelected, as follows: H. M. Daugherty, Columbus, Ohio, president; H. M. Aubrey, San Antonio, vice-president; D. A. Walker, Columbus, Ohio, secretary and general manager; A. L. Beze, San Antonio, superintendent; Ferdinand Herff, Jr., San Antonio, treasurer; Cyrus Huling, Columbus, Ohio, member of the board of directors. At the next meeting of the board of directors the matter of extensions will be taken up.

SCHENECTADY, N. Y.—The new telephone line between this city and Amsterdam, which will be under the control of the Home Telephone Company, has been placed in operation. The line also connects Pattersonville with the city, and in order to do this it was necessary to have a span across the Mohawk 750 feet long. The company has a gang of men on the new line it is building to Utica, and it is hoped to have this completed within three months. The opening of the Amsterdam line gives Schenectady service with Fonda, Johnstown and Gloversville over the Home company's lines.

TOLEDO, OHIO—The Wabash Railroad is about to install long-distance telephones along its entire system. The old road from Toledo to St. Louis has been wired, and operating forces are now at work between Detroit and Montpelier and on the Chicago division. Construction will be pushed as rapidly as possible, and it is said that the new method will do away with about fifty per cent of telegraphing on the Wabash road. An operator will be located at each town and station where the telephone is installed. The scheme of wiring will allow one wire to be used at the same time for telephoning and telegraphing, without interference of any kind.

OBITUARY NOTICES.

MR. ALBERT A. HONEY died on December 5, at Chicago, Ill., in the Chicago Union Hospital. Mr. Honey was an old-time telegrapher, beginning when twelve years old with the old Illinois Telegraph Company. He was one of the first of three operators employed by the Associated Press in Chicago. Later on he entered the employ of the Union Pacific Railroad Company, and afterward superintended the construction of the lines of the Northern Pacific from Bismarck to the Pacific coast. Mr. Honey settled in Chicago in 1901, and until within the last two months was president of the Magnetic Equipment Company. He was one of the organizers of the Old-Time Telegraphers' Association.

MR. ALBERT J. WISE, of the law firm of Quackenbush & Wise and president of J. H. Bunnell & Company, manufacturer of electrical supplies, died at his home, 533 West 162d street, New York, December 13, 1903. His death was due to bronchitis following internal injuries received a week before, when he slipped and fell near his home while alighting from a trolley car. Mr. Wise was born in Lima, Ohio, September 24, 1869. He took the degree of LL. B. at Yale and afterward at Columbia University. After his graduation Mr. Wise practised law for some time in his native town, but removed to New York in 1891. He was interested in yachting, owning the steam yacht Chetolah, and was a member of the New York Yacht, Atlantic Yacht and Sea Cliff Yacht clubs. He was also inspector of public schools for the boroughs of Manhattan and the Bronx.

PERSONAL MENTION.

DR. HORACE CLARK RICHARDS, instructor in physics in the University of Pennsylvania, has been made assistant professor of physics.

MR. A. A. ANDERSON has accepted the position of general superintendent of the Indianapolis-Cincinnati Traction Company, with headquarters at Indianapolis, Ind.

MR. WILLIAM C. ANDREWS, of New York, has just accepted the position of engineer of the sales department of the Stanley Instrument Company, Great Barrington, Mass.

MR. JOHN B. McCLARY has resigned as manager of the street railway department of the Birmingham Railway, Light and Power Company, Birmingham, Ala., to take effect January 1.

MR. W. J. CAMP, superintendent of the eastern division of the Canadian Pacific Railroad Company's telegraphs, has been appointed chief electrical engineer to the whole telegraph system of that company.

MR. THOMAS M. JENKINS, formerly general manager of the St. Louis & Suburban Railway Company, has been elected president and general manager of the Imperial Transit Company, of St. Louis, Mo.

MR. WM. M. DYATT has resigned as superintendent of the Lehigh-Northampton Gas and Electric Company, Allentown, Pa., to engage in business as an electrical contractor. He will open an office in the Willoughby Building, Catasaqua, Pa.

MR. C. O. HARRIS, formerly superintendent and engineer of the Rochester Telephone Company, Rochester, N. Y., has associated himself with the sales department of the Stromberg-Carlson Telephone Manufacturing Company, and is now located at Chicago, Ill.

MR. RANDOLPH G. SHARPE, for a number of years confidential employé of the Sterling Electric Company, La Fayette, Ind., has resigned to take charge of the collecting department of the Bell Telephone Company for Indiana, Ohio and Illinois, with headquarters at Indianapolis.

MR. JAMES W. CROSBY, chief electrician of the Halifax Electric Tramway Company, Halifax, N. S., has been appointed general manager of the company to succeed Mr. F. A. Huntress, who resigned from the company to become general manager of the Worcester Consolidated Street Railway Company, Worcester, Mass.

MR. EUGENIO DAVERI, who has been constructing superintendent of the Italian Edison Company, Milan, Italy, for the past ten years, has tendered his resignation in that capacity and on January 1 will act as representative for foreign manufacturers of vehicles of all kinds, such as cars for steam and street railways, automobiles, etc., and also for car supplies. The Italian Edison Company, with which Mr. Daveri has been connected, operates all of the electric street railway lines in Milan.

MR. THOMAS J. JOHNSTON and MR. GEORGE C. DEAN announce that their offices are now located at No. 11 Pine street, New York city. Mr. Johnston has had wide experience in the United States courts, especially in equity, and will continue to give attention to patent cases, proceedings in admiralty, removal of cases from state to federal courts, bankruptcy and other federal cases. Mr. Dean is a graduate of Amherst College, and studied law at Harvard. He has been a member of the bar for nine years, and as principal examiner in the electrical, metal-working, woodworking and other divisions of the Patent Office, has acquired an intimate knowledge of these arts and of the most recent advances in telephony, wave transmission, wireless telegraphy, mercury vapor lamps, Nernst lamps, etc. He will make a specialty of expert legal opinions on patentability, validity and infringement.

MR. WALTER H. WHITESIDE, manager of the detail and supply department of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., has been made the general manager of the Sawyer-Man Electric Company, and has added the duties of this new office to his former ones. Mr. Whiteside is well known in the electrical field, as he has been connected with this interest for nearly twenty years, extending his acquaintanceship to every part of the country. Mr. Whiteside became a special salesman for the Westinghouse Electric and Manufacturing Company in Chicago in 1898. A year later he was sent to Washington, D. C., to take charge of sales to the government. This led, in 1900, to his being made manager of the company's office for that district, then having its headquarters in Washington. From the Washington office Mr. Whiteside was promoted to the management of the detail and supply department of the company, with headquarters at Pittsburg. Under his management the business of the department has increased greatly.

ELECTRICAL SECURITIES.

The closing prices on Saturday showed a good rally, but were not the highest for the week, there being a slight falling off in the last day's buying. In spite of this rally, however, there is not so much confidence as existed a week ago, the disturbing factor in the immediate speculative situation being the opening of the Northern Securities case in the Supreme Court. Brooklyn Rapid Transit and the electrical securities in general were freely dealt in, maintaining the advances of the previous week.

The preliminary November statement of export trade is good, and trade reports and economic conditions in general are expected to provoke a very hopeful sentiment.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 12.

New York:	*Closing.*
Brooklyn Rapid Transit	48
Consolidated Gas	182¾
General Electric	164
Kings County Electric	180
Manhattan Elevated	140½
Metropolitan Street Railway	121
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	180

At the annual meeting of the stockholders of the Metropolitan Street Railway Company retiring directors were reelected.

A quarterly dividend of 1½ per cent on the capital stock of the Manhattan Railway Company will be paid on and after January 1, 1904, to stockholders of record at the closing of the transfer books on Friday, December 11, 1903, at 3 o'clock P. M. The transfer books will reopen on Tuesday, December 22, at 10 o'clock A. M.

The board of directors of the Western Union Telegraph Company has declared a quarterly dividend of 1¼ per cent upon the capital stock of this company, payable at the office of the treasurer on and after the fifteenth day of January next, to shareholders of record at the close of the transfer books on the nineteenth day of December inst. The transfer books will be closed at 3 o'clock on the afternoon of December 19 inst., and reopen on the morning of January 2 next.

A dividend of $2 per share will be paid on January 15, 1904, to holders of stock of the General Electric Company of record at the close of business hours on Saturday, December 19, 1903.

Boston:	*Closing.*
American Telephone and Telegraph	124½
Edison Electric Illuminating	230
Massachusetts Electric	76
New England Telephone	122
Western Telephone and Telegraph preferred	81

At a directors' meeting of the Edison Electric Illuminating Company, directors recommended stockholders to authorize an issue of 95,000 shares of new stock, to be subscribed for early next year. The new stock is to partly capitalize recent purchases of suburban properties.

The annual report of the Massachusetts Electric Companies for the year ending September 30 shows a surplus after dividends of only $6,622, which compares with $195,167 in the previous year. The income account is as follows: gross earnings, $6,333,911; operating expenses, $4,155,909, leaving net earnings of $2,178,002; paid for interest, rent, taxes and dividends, $2,171,380, leaving a balance of $6,622. During the fiscal year there was expended $2,570,000 for cars, track reconstruction, power stations, and lands and buildings, while for new roadway and new tracks there was spent only $460,000. It is stated that the large falling off above noted is due to the general rise in the price of all supplies and the increase in wages, while the gross earnings were greatly reduced by the unfavorable weather conditions which prevailed during the summer months.

Philadelphia:	*Closing.*
Electric Company of America	7⅞
Electric Storage Battery common	53
Electric Storage Battery preferred	53
Philadelphia Electric	6⅛
Union Traction	45⅝
United Gas Improvement	82⅝

The directors of the United Gas Improvement Company have declared a quarterly dividend of 2 per cent, payable January 15, 1904, to stockholders of record at the close of business December 31, 1903.

Chicago:	*Closing.*
Chicago Telephone	123
Chicago Edison Light	144½
Metropolitan Elevated preferred	51
National Carbon common	17½
National Carbon preferred	89
Union Traction common	6
Union Traction preferred	29

It is stated that Chicago Union Traction will issue capital to raise at least $3,000,000, to be spent on improvements. The plans contemplated will, it is expected, increase earnings about 35 per cent.

INDUSTRIAL ITEMS.

THE SPRAGUE ELECTRIC COMPANY, New York city, is sending out instruction book No. 104. This gives definite instructions for the installation and care of direct-current "M. L." type generators.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., sales agent for Packard lamps, Zenith "intermediate" lamps and Adams-Bagnall arc lamps, is distributing a complete line of new lamp literature. This will be sent to any one interested upon request.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports a very gratifying increase in its socket business, which it attributes to the appreciation by the electrical trade of its automatically produced sockets, which are very uniform and cost little to install.

THE CROUSE-HINDS COMPANY, Syracuse, N. Y., has been incorporated with the secretary of state, to take over the property and rights of the Crouse-Hinds Electric Company. The capital is $450,000. The directors are Huntington B. Crouse, Jesse L. Hinds and David B. Costello, of Syracuse.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, announces that its claim to the exclusive rights under the Ward Leonard patents to install the multiple voltage system of electric drive for operating machines has been sustained. This decision was rendered by Judge Kirkpatrick, of the Circuit Court, December 2, 1903.

THE PITTSBURG TRANSFORMER COMPANY, Pittsburg, Pa., has issued a neat folder illustrating several types of Pittsburg transformers. The transformers illustrated are made with fluted sheet-steel cases, with cast-iron base and top, finished in black japan, in sizes from 30 to 250 kilowatts, and voltages from 2,000 to 25,000. This circular will be sent on request.

THE EDISON STORAGE BATTERY COMPANY, Orange, N. J., has published a catalogue describing the Edison storage battery. This gives a number of excellent half-tone engravings, showing the assembly and construction of the battery, and a technical description of it. This catalogue also presents an engraving showing the mechanical works at Glen Ridge, N. J., and the chemical works at Silver Lake, N. J.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., will be pleased to send to any one interested an illustrated catalogue descriptive of electrical novelties and appliances for boys. This includes miniature electric locomotives, electric trolley cars, derrick trailers, suspension bridges, battery fans, medical batteries, Morse outfits, private line battery call telephones, battery motors, battery lamps and electrical heating apparatus.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is sending out a circular calling attention to "D. & W." panel fuses and their adaptability for use with Adams-Bagnall and other makes of arc lamps. A connector is shown, by the use of which "D. & W." fuses can be fitted to any arc lamp without the necessity of a fuse block. The members of the firm are enthusiastic over the increased volume of business they are doing on "D. & W." material generally.

THE FARR TELEPHONE AND CONSTRUCTION SUPPLY COMPANY, Chicago, Ill., has adopted a novel method of presenting prospective buyers of telephone apparatus with ready reference sheets of specifications and prices. A recent folder contains illustrated descriptions and data concerning batteries, linemen's tools, transmitters and receivers, line supplies, telephones, toll line switchboards and express switchboards. This literature will be sent on request.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, in its catalogue No. 52 describes and illustrates a complete line of Jeffrey coal-washing machinery. This catalogue also includes a number of testimonials from prominent users of the Jeffrey apparatus. The Jeffrey company also manufactures elevating, conveying, power transmission, screening, crushing, coal-cutting, drilling and hauling machinery. Catalogue No. 52, or any of the other catalogues which this company distributes, will be sent upon request.

THE MONTAUK FIRE-DETECTING WIRE COMPANY, 100 Broadway, New York city, is in receipt of a letter from Thomas Oakes & Company, manufacturer of woolen goods, Bloomfield, N. J., commendatory of its fire-detecting wire. Several months ago this company fitted a 160-degree fire-detecting wire to its main head shaft bearing. On the morning of December 1 this gave an alarm of an overheated bearing, and the low temperature at which this was given enabled correction of the trouble without any serious result.

THE STARK TELEPHONE, LIGHT AND POWER SYSTEM, LIMITED, with a capital of $1,000,000, has been formed in Toronto, Canada, to take over the Humber Light and Power Company, at Toronto Junction. The new company will operate the Stark patents, whereby telephone, telegraph, light and power service is furnished from the one plant and over the same circuit. The company will greatly increase the Humber Light and Power Company's plant, and will immediately commence installing a telephone service in Toronto Junction, for which town it has secured a franchise.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., will be pleased to send bulletin No. 65 to any one interested in lighting and motor transformers. This bulletin illustrates the back view of a standard transformer, showing pocket for hanger lugs and full set of twenty-kilowatt coils, depicting the method of assembling and the standard construction for both motor and lighting transformers. There is also illustrated the construction for the twelve, twenty and thirty-light sizes and a horizontal section through a twenty-kilowatt type "M" transformer, showing the provision for oil circulation.

THE HENRY R. WORTHINGTON COMPANY, New York city, has issued a pamphlet entitled "Water-meters," describing its new disc meter and illustrating the internal construction. The pamphlet also describes the standard duplex piston meter, which is well known to engineers. There is also a description of the Worthington hot-water meter, which has wide use in checking up the evaporative values of different grades of coal, the efficiency of firemen, etc. The typography and makeup of the pamphlet are good, and it is of a convenient size for quick reference. This is worth asking for, and the company will be pleased to mail on request.

THE TRACTION DEVELOPMENT AND SECURITIES COMPANY, 74 Cortlandt street, New York city, has been incorporated under the laws of the state of New York. This company purposes aiding in the formation of syndicates, the underwriting of securities, the promotion of consolidations and construction, and the financing of steam and electric roads, gas, water and electric light plants. Expert reports and opinions will be furnished concerning properties and enterprises of any kind in contemplation. Besides technical conditions, the company will cover a study of the market supply and demand, and a full account of economic and commercial details. Financial agents are stationed in all of the principal cities. The corporation will look into various enterprises and have these thoroughly examined by experts of national repute. The directors of the company are well known in railroad and financial interests.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is distributing several price lists and bulletins, and also several illustrated articles on engineering apparatus. This literature includes descriptions of single-wire porcelain cleats, electric lighting outfits for ready decorations, the GE-74 motor, type CR feeder regulators, and induction motors. A booklet entitled "Multiple Enclosed Arc Light Systems" shows forth the advantages of interior lighting by long-burning multiple enclosed arc lamps. The statement is made that there are at present in use for interior lighting in the United States 550,000 multiple lamps, of which the General Electric Company has furnished about 325,000. During the past five years there have been marked changes in the design and manufacture of enclosed arc lamps, and the General Electric Company has taken a leading part in these improvements. This booklet tells concisely of the installation, mechanism and operation of these lamps. A booklet entitled "Fifteen Years' Experience in Transformer Manufacture" gives a most instructive and interesting review of transformer history. It takes up briefly the work of Faraday, Ruhmkorff, Varley and Ferranti, and illustrates the development of transformer construction. A number of the illustrations used have already become familiar to engineers, but the work loses none of its attractiveness or importance because of this, as these illustrations are necessary to show the high degree of excellence to which transformer construction has been raised.